BREWING SINGLE HOP BEERS | BELGIAN STRONG GOLDEN ALE | SOUTHERN STYLE HOP GROWING

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THE HOW-TO HOMEBREW BEER MAGAZINE

MARCH-APRIL 2011, VOL.17, NO.2

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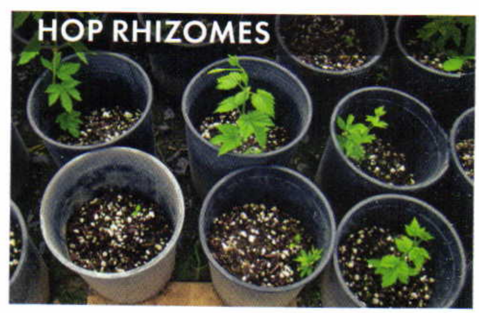
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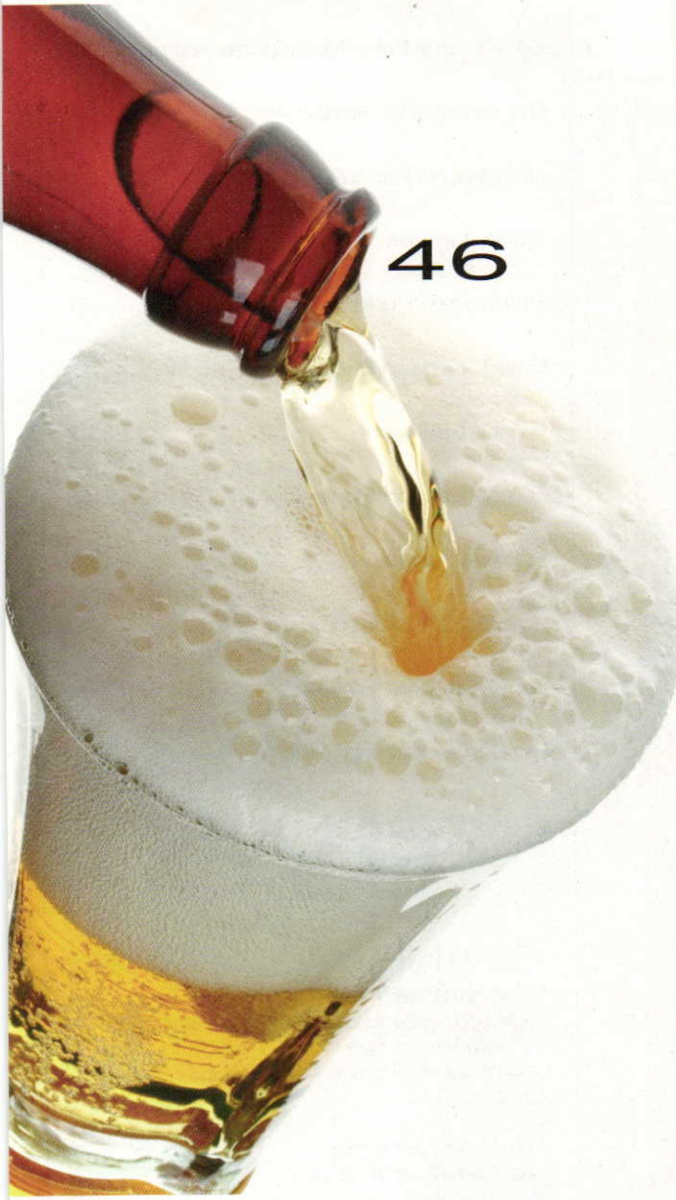




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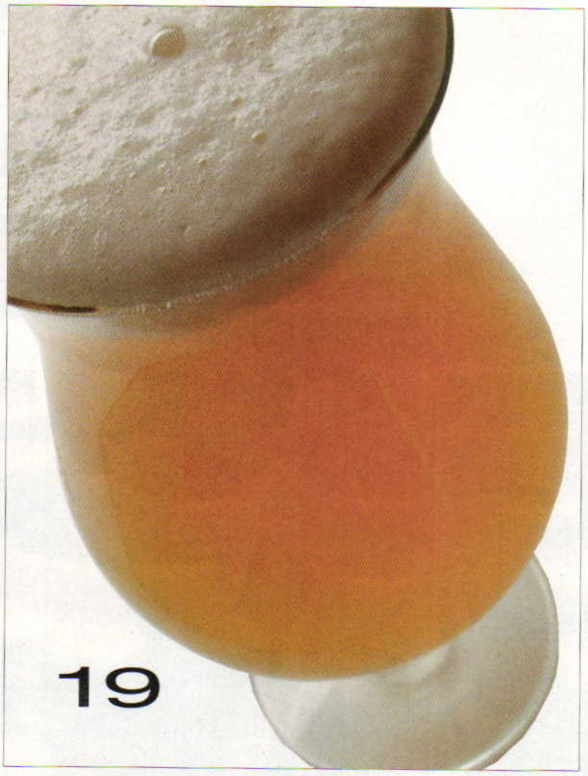

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# departments



## where to find it



# RECIPE INDEX



## 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) = 1.033–1.037
dried malt extract (DME) = 1.045

**Potential extract for grains:**
2-row base malts = 1.037–1.038
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 IBUs based on 25% hop utilization for a one hour boil of hop pellets at specific gravities less than 1.050.

# what's happening at BYO.COM

## Maibock: Style Profile

Bockbiers also change their color with the seasons. As a general rule, they start out deep amber in the fall, turn progressively darker as the weather gets colder, and then become lighter again with the onset of spring. Maibock is the palest of the Bavarian bockbiers, often called Helles or Heller Bock.
http://www.byo.com/stories/beer-styles/article/indices/11-beer-styles/1040-maibock-style-profile

## BYO Videos: Growing Hops

Learn some basic tips for growing backyard hops that you can use in your own recipes. Spring is in the air and orders for rhizomes will be filling up fast, so do your homework today.
http://www.byo.com/videos/24-videos/1800-growing-hops


## Barleywine & Doppelbock: Style Calendar

As a tradition, we always brew two beers in the month of December, but it is not too late to knock off a batch now and tuck it in the cellar for a long lagering. For more information on these two great recipes.
http://www.byo.com/component/resource/article/117-Departments/169-barleywine-doppelbock-style-calendar

Cover Photo: **Charles A. Parker**


**Brew** THE HOW-TO HOMEBREW BEER MAGAZINE YOUR OWN

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Special Subscription Offer
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***Brew Your Own*** (ISSN 1081-826X) is published monthly except February, April, June and August for $28.00 per year by Battenkill Communications, 5515 Main Street, Manchester Center, VT 05255; tel: (802) 362-3981; fax: (802) 362-2377; e-mail: BYO@byo.com. Periodicals postage rate paid at Manchester Center, VT and additional mailing offices. Canada Post International Publications Mail Agreement No. 40025970. Return undeliverable Canadian addresses to Express Messenger International, P.O. Box 25058, London BC, Ontario, Canada N6C6A8. POSTMASTER: Send address changes to ***Brew Your Own,*** P.O. Box 469121, Escondido, CA 92046-9121. Customer Service: For subscription orders call 1-800-900-7594. For subscription inquiries or address changes, write ***Brew Your Own,*** P.O. Box 469121, Escondido, CA 92046-9121. Tel: (800) 900-7594. Fax: (760) 738-4805. Foreign and Canadian orders must be payable in U.S. dollars plus postage. The subscription rate to Canada and Mexico is $33; for all other countries the subscription rate is $45.




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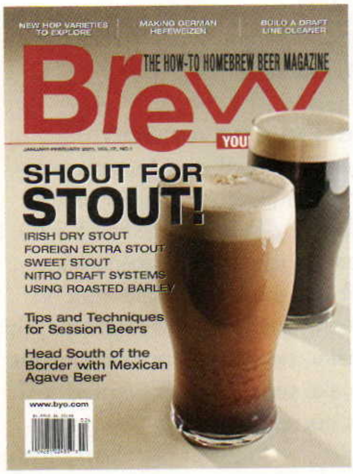



### Chart credit

*In the January-February 2011 installment of "Advanced Brewing," the attributions for the charts showing the wavelengths of light that penetrate variously colored bottles were inadvertently omitted. The charts came from Dr. Brad Sturgeon, of Monmouth College and represent original work he has done in his lab.*

### A crushing dilemma

I read with interest the January-February 2011 story on dry stout. One thing that article did not address, however, was is there a need to mill your dark grains separately? I have read somewhere that not only do you need to do this, but you need to mill the dark grains very finely also.

*Mark Long*
*Sanford, North Carolina*

*Article author, and* BYO *Editor, Chris Colby responds: "Dark grains are highly-roasted and therefore smaller than pale malts, as they lose weight in the kiln. Some brewers deal with this by milling their pale malt(s) and dark grains separately, tightening the mill gap slightly when they do. Others, like myself, don't bother.*

*"Whether to grind the grains separately or even to grind the dark grains very finely is a matter of personal taste, and there are consequences to taking either path. Grinding more finely results in a darker colored wort, because there is more surface area (especially husk edge area) exposed to the wort if the husk is ground into numerous small pieces compared to a few large bits of husk. Grinding more finely also releases more tannins into the wort for the same reason. Finally, grinding more finely can lead to lautering issues.*

*"So basically, you get more color and flavor from your dark grains if you grind them finely, but also more tannins and the potential for problems during lautering. Because dark grains are known to be more prone to releasing their tannins, and dark grains sometimes cause lautering problems, I simply mix my dark grains into my pale malt and mill them at a gap setting adjusted to mill the pale malt correctly. I'm undercrushing the dark grains this way, but I've tasted*



Sean Z. Paxton is also known as The Homebrew Chef. He was a professional chef for years and has been a homebrewer since 1993. Combining these two talents, he has prepared several high-profile dinners, including those made for the Northern California Homebrew Festival.

Many of his beer-inspired recipes and menus can be found on his website, www.homebrewchef.com.

In this issue, on page 26, Sean describes how to put the yeast-derived characters found in German weizenbeirs — the banana and the cloves — to use in recipes for hefeweizen pancakes, Indian tamales and hefeweizen pudding.

Jamil Zainasheff is *BYO*'s "Style Profile" columnist, covering the world's beer styles from amber ales to zwickelbier. (Or at least, we're sure he'll get to zwickelbier someday.) Together with Chris White, he has recently written, "Yeast: A Practical Guide to Beer Fermentation" (Brewers Publications). Jamil has also announced that he is starting his own commercial brewing company — Heretic Brewing Company, in Pittsburg, California. You can read about his journey from homebrewer to commercial brewer on his blog, found at www.byo.com.

In this issue, on page 19, the heretic himself describes how to brew a "devilish" beer style, Belgian Strong Golden Ale.

Terry Foster was born in London, England and holds a PhD in chemistry from the University of London. He now lives part of the year in the United States and occasionally helps out with the brewing at New Haven, Connecticut's BruRm @ BAR brewpub. Foster is known to many as the author of the books in the Classic Beer Style Series, "Pale Ale" and "Porter" (Brewers Publications) and is now the author of *Brew Your Own's* "Techniques" column. He has also written feature articles for *BYO* including a piece on ancient Egyptian beer and a profile of Scotland's Brewdog Brewery. On page 57, Dr. Foster discusses brewing single hop beers as a way of evaluating hop varieties.

*and fine-tuned my recipes based on crushing this way and if I'm adding a fraction of an ounce more dark grains to get the color and flavor I want, I'm not going to worry about that. If you'd like to get more from your dark grains, and aren't worried about astringency (a little of which is fine in a dark brew) or lautering problems — or the extra time it takes to adjust your mill and grind separately — go ahead and experiment with tightening up your mill a bit and grinding the dark grains separately.*

*"Another thing some brewers do that I did not mention was to mill the grains separately, mash in the pale malts first, then stir the dark grains into only the top part of the grain bed. The idea here is to prevent lautering problems. (I have even heard of homebrewers mashing the pale grains first, and only adding the dark grains a few minutes before beginning to run off the wort.)*

*"Even that doesn't end your options. You can brew a pale beer from the pale malts, separately brew a super dark beer with a huge proportion of dark grains and blend them. (I've even heard of homebrewers separately cold steeping their dark grains over night and adding this liquid to their mash or kettle the next day.)*

*"Whatever method you choose, keep in mind that there is no right or wrong as long as the beer turns out to your liking. Every decision you make will have consequences, but homebrewers employ a lot of different twists to brewing their dark beers with good results."*

### Sweet stout soured in conversion

I am having trouble understanding the extract conversion of the sweet stout recipe (page 46) in your article about dry stouts in the January-February issue of *BYO*. I do not see a plain pale malt in the original grain recipe and do you replace all 8 lbs of the UK pale ale malt or just 7 lbs? I am currently only brewing with extracts with grains. I would love to make the sweet stout recipe, but the conversion doesn't make sense, so just wanted to make sure I am reading it correctly.

*Jeff Buxton*
*via email*

*We used pale malt and pale ale malt interchangeably in the extract conversion. Use the amounts specified in the extract recipe — 0.50 lb. (0.23 kg) UK pale ale malt, 1 lb. 10 oz. (0.74 kg) dried malt extract and 3.3 lbs. (1.5 kg) of liquid malt extract — to yield the correct recipe.*

### Bigfoot bittering question

I am confused by the hop schedule on the Bigfoot clone recipe (November 2010 issue). It says it will have an IBU rating of 94. The recipe directs one to, "Remove the previously added hops, from the wort after adding the 0-minute addition." Should this say, "...from the wort before adding the 60-minute addition"? If not, and both the FWH and the 60 minute hops remain in the wort during the boil, the IBU will be double, at least that is what my program is saying. So, could you please clear up the hop schedule? Thank you for the outstanding publication. Keep up the great work.

*Mark Pugh*
*Little Hocking, Ohio*

*The recipe is correct as presented. After the boil, remove the bittering hops and first wort hops (FWH) and add the knockout (0-minute) hops. You can put the FWH and bittering hops in nylon bags to make them easy to remove, or rack the beer from the kettle to a whirlpool vessel and add the knockout hops.*

*The recipe contains a lot of first wort hops (FWH), and this may be why your program is calculating a higher IBU value. In practice, this doesn't really matter as there is an upper limit to the amount of IBUs you can obtain from boiling hops. However, adding hops beyond this point does result in more hop flavor and aroma. Follow the recipe and enjoy your barleywine.*

## Ounces of invert sugar

See Young's Double Chocolate Stout clone, on page 6 of the *250 Classic Clone Recipes* special issue. The recipe calls for 8 oz. of invert sugar. Is this 8 oz. of liquid or dry weight? I think the recipe is 8 oz. of dry weight. So far I have only found the invert sugar in liquid form. What would be the required quantity of liquid invert sugar for this recipe?

*Ron Haggerty*
*via email*

*All the sources of invert sugar we know of come in liquid form. The recipe refers to 8 fluid ounces of sugar.*

## Bitter brewing liquor

Some brewers use phosphoric acid to acidify their brewing liquor if it contains excess carbonates. Could I add hops (or hop extract) and use the alpha acids for this? How much hops or extract would I need to add?

*Jeff Ray*
*Clarkdale, Arizona*

*The alpha acids in hops aren't strong enough to make much of a difference to your water chemistry. Even adding a large amount would likely have little effect.* BYO

# homebrew nation

## CLUB PROFILE

**Club Name:** Dublin Malts

**Hometown/State:** Dublin/Columbus, Ohio

**Years brewing:** Five

**Meeting Location:** Member homes

**Number of Members:** Eleven

**How it all started:**
It all started when I (Lance Clark) visited Germany and really liked the beer. I came home and really wanted to replicate the flavors. I started brewing 22 years ago and over time others joined in.

**What we're up to these days:**
Brewing and aging beers for winter and spring: wee heavy, doppelbocks, Maibocks, Christmas ales, Belgian ales — and leaning towards high gravity varieties.

**Biggest event:**
Oktoberfest (O-fest), which takes place at the end of September/beginning of October. Last year more than 300 people attended. In addition to food, dancing and lawn games, we had 110 gallons (416 L) of various homebrews on tap. We even built a tap wall to resemble a half-timbered German wall for all our taps (22 in all), and one of our members, an art teacher, made an official O-fest stein to give away.

## CLUB RECIPE

### Lance's Ein Prosit O-Fest Märzen

**(6.5 gallons/25 L, all-grain)**
OG = 1.061 FG = 1.013
IBU = 19 SRM = 14 ABV = 5.9 %

**Ingredients**
Distilled water
Water treatment: 1 gram Epsom salt, 0.5 grams canning salt, 3.5 grams chalk
8 lbs. (3.6 kg) Munich malt
4 lbs. (1.8 kg) Vienna malt
6.5 oz. (184 g) Caramunich I® malt
5.50 AAU bittering hops at one hour
0.5 ounces Mt. Hood at 15 minutes
Wyeast 2206 (Bavarian Lager) yeast
1 Whirlfloc tablet

**Step by Step:**
Mash grains with treated water at 152 °F (67 °C) for 1 hour. (90% efficiency assumed in recipe.) Sparge with 5.0 gallons (19 L) water at 175 °F. Vigorously boil for 90 minutes. Add bittering hops after the protein break. With 15 minutes left, add the flavoring hops and the Whirlfloc tablet.

Cool the wort to pitching temperatures and transfer to your primary fermenter. Add the yeast and aerate the wort for about ten minutes. Ferment at 47-52 °F (8-11 °C) for around fourteen days. Raise temperature to 62 °F (17 °C) until fermentation stops. Transfer to secondary fermenter and lager for at least eight weeks at 33 °F (0.5 °C). Keg, carbonate and consume for your own O-Fest.

## byo.com brew polls

### Do you ever brew session beers?

Yes, from time to time: 40%
Yes, all the time: 25%
No, but I want to: 25%
No, I'm not interested 10%

## social homebrews

Join *BYO* on Facebook: www.facebook.com/BrewYourOwn

Follow *BYO* on Twitter at: @BrewYourOwn

# what's new?

### Randall the Enamel Animal 3.0

Randall is an "organoleptic hop transducer module." Sam Calagione, Dogfish Head founder, clarifies: "Basically, it's a sophisticated filter system that allows the user to run draft beer through a chamber of whole leaf hops, spices, herbs, fruit, etc. so that the alcohol in the beer strips the flavor from whatever you add and puts it in the beer." This third edition of the Randall cuts down on foaming with a double cartridge system. Available at www.dogfish.com


### Analog Temperature Controller for Fridge, Freezer, or Air Conditioner

This thermostat form Home Brew Stuff is perfect for controlling the temperature of your freezer, refrigerator, or air conditioner. Also use it for fermentation or lagering. It is easy to use, just plug it in, and then plug in the appliance you want to control to the back of the box. The unit comes with a 5 foot extendable stainless steel sensor, which is safe to submerge or use in a thermowell. The temperature range can be set from 30° F to 110° F (+ - 2° accuracy), and the maximum appliance load is 16A 110v. Available at www.HomeBrewStuff.com


## calendar

### March 4-6
### Bockfest 2011
### Cincinnati, Ohio

In the 1800s, Cincinnatians drank more beer per capita than any city in the country, and Bock beer is a delicious, rich, complex, and robust lager that marks the end of the winter brewing season and the beginning of spring. So naturally, the two were bound to come together for a festival! As a special prize in the homebrew competition, the Christian Moerlein Brewing Company will select one entry from the Traditional Bock (5B) category to be used as the recipe for their special 2011 Bock release.
Entry Fee: $6 first. $4 subsequent
Deadline: February 25
Web: http://www.bloatarian.org/content/view/98/91/
Phone: (513) 759-2573
Email: raysnyder@fuse.net

### March 12
### Drunk Monk Challenge
### Aurora, Illinois

The Urban Knaves of Grain homebrew club presents their 13th annual Drunk Monk Challenge homebrewing competition. An MCAB qualifying event, and a part of The Midwest Homebrewer of the Year award, all BJCP categories are included. Judging will take place at America's Brewing Company in Aurora, Illinois on the date listed above.
Entry Fee: $6
Deadline: March 4th
Web: http://www.knaves.org/DMC/index.htm
Phone: (630) 525-0283
Email: drunkmonkchallenge@gmail.com

### April 2
### 2011 World Cup of Beer
### Berkeley, California

The Bay Area Mashers homebrew club are proud to continue their tradition of running this competition, which is open to everyone, regardless of location (638 entries from across the US last year).
Deadline: March 12
Phone: (510) 338-1221
Web: http://www.worldcupofbeer.com/
Email: dave@justblank.com

# homebrew **drool systems**

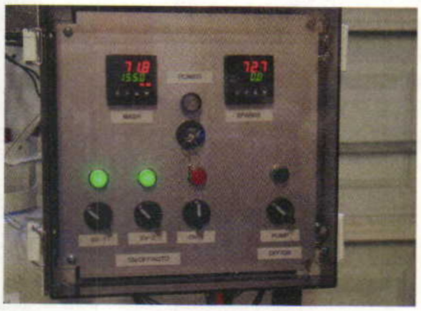
## Jackie Boy Brewery

Nate Nord • Williamsburg, Pennsylvania

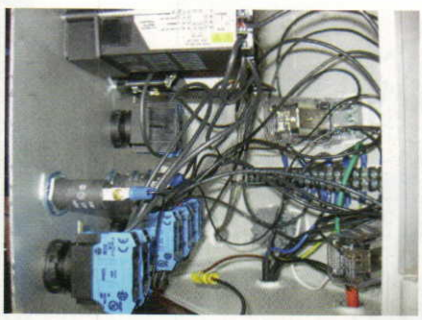
My brewery began because of a love of real Scottish ales and their relative obscurity in the local and craft brew markets. After sampling some homebrews from friends, my wife and I decided to build a home brewery and focus primarily on Scottish ales. I have a background in process control systems. So, I decided that it would be a good idea to incorporate some automated controls into the system. After looking at numerous other systems and spending a little more time studying the brewing process, I settled on the HERMS design.

The rear of the brewery is where it all comes together. Items of interest include the wort drain manifold (drains the entire system to a low point) and the propane manifold. The propane manifold is composed of a gas solenoid valve, brass piping, and brass gas isolation valves for each burner. The propane manifold also includes a ¼-inch pilot line (far left) that supplies a pilot light for the HLT burner. The burners for the kettle and mash tun are manually controlled.

One PID controller senses the thermocouple temperature at the outlet of the mash tun and controls recirculation flow either into the HLT (to raise the wort temperature) or bypasses the HLT to allow ambient losses (lower the wort temperature). The second controller senses thermocouple temperature in the HLT and cycles a propane solenoid valve on or off to maintain temperature there.



The control system consists of an industrial enclosure, two PID controllers with thermocouple sensors, two relays, switches for the solenoids and wort pump, and associated indicating lights. Below, you can see the interior of the controller enclosure. On the left side, from top down are the PID controllers, power switch, indicating lights, and switches. The right side consists of a terminal strip and the output relays, which control the solenoids.



The system was a lot of fun to build, and, considering it was built from mental notes and scribbles on scrap pieces of paper, it works quite well. If I had to do it again, though, I would probably do one of two things differently. I would either use all manual valves/controls (the automation contributed heavily to the build time and cost), or I would build the control system to make use of some type of variable control, as opposed to simple on/off HERMS coil and bypass flow. I may even end up modifying the system a little to allow for this.

# YEAST NUTRIENTS BASICS

by betsy parks

In a perfect batch of homebrew, brewers yeast should fully ferment the wort — never sticking or stopping. That is not always the case, however. Yeasts need more than just fermentable sugar to survive and thrive, and without enough nutrients, your beer can suffer. Adding yeast nutrients is an easy way to make up for what might be lacking in your wort.

## What are yeast nutrients?

Yeast nutrients are additives that can be added to wort that the yeast can use to build proteins and eventually new cells. Yeasts need free amino acid (FAN), lipids and vitamins, especially thiamine or Vitamin B1, as well as minerals including calcium, potassium, magnesium and zinc. An all-grain batch of beer usually has all the nutrition yeast need for fermentation. In fact Professor Wildiers with the University of Louvain in 1900 named the mysterious compound associated with yeast vigor as "bios;" this substance could be obtained from yeast cells and was also present in wort. Scientists later discovered that Vitamin B1 was most likely the biologically active compound present in bios.

However, some extracts, including beer kits, can sometimes lack some of the necessary nutrients yeast need to grow. Some of the most common types of yeast nutrients available to homebrewers include Di-ammonium Phosphate (DAP), yeast hulls, prepackaged "yeast nutrient" or "energizer," which are prepackaged mixtures of different nutrient ingredients, such as Brewer's Choice Nutrient Blend from Wyeast, and Servomyces, which is a specialty product from Lallemand and White Labs.

Note that the latter nutrients are all sources of Wildiers' bios as they all contain yeast or lysed yeast. The Servomyces product is grown in a zinc-enriched media and contains more biologically available zinc than normally grown yeast. Zinc is a very important enzyme co-factor and also influences yeast flocculation, where increased zinc levels increases flocculation after fermentation.

## When to use nutrients

There are a few common reasons why wort may not contain the proper amount of nutrients. As mentioned above, extracts can sometimes not provide as much as an all-malt brew, especially FAN. Adding refined sugars to a batch, such as cane, corn or candi sugar or by using adjunct grains, like rice or corn, can also be a problem as these ingredients dilute the nutrient content of all-malt wort. Nutrient supplements are especially important in meadmaking since honey contains far less nutrients than wort. In fact yeast nutrients are useful for any brews where the yeast may experience pressure or stress — such as high gravity brews, or if your yeast has been stored for too long, as this can deplete its nutrients. It is also a good idea to add nutrients to yeast starters as they are often started with malt extract.

## How to use?

If your beer (or mead) meets any of the criteria that could call for yeast nutrients, explore your options before blindly adding anything to your beer. Your local homebrew supplier will likely be able to recommend a good product. For example, DAP is strictly a nitrogen supplement, which can be useful if you think your fermentation just needs a kick. If you are brewing something that needs a little more oomph, however, you could try using a nutrient blend, which will have a more complete range of ingredients.

Each nutrient will have different instructions, depending on the manufacturer, but they will all be added after the boil with the yeast, unless you are adding them to a starter. You can also add nutrients if you are experiencing a stuck fermentation, but it's often best to add them to a yeast starter when you repitch the yeast. Most nutrients will also provide instructions for how to add 1 gram per liter by dissolving it in water, so you will need to scale up for your batch size.

## grain profile

### MUNICH MALT

Munich malt has a sweet, toasted flavor and aroma and adds an amber to brown color to beer. It generally has enough diastatic power to convert itself, but will need help from other malts to convert other grains. Munich is most often used in German-style lagers, such as bocks, as well as dunkels and Märzens. It is unique and versatile in that it is a darker grain than pale malts but not technically considered dark itself (although it comes in both light and dark variations).

by marc martin

## DEAR REPLICATOR,

I FOUND AN UNUSUAL BUT VERY TASTY BEER CALLED MATACABRAS AT A LOCAL STORE. IT IS IN SHORT SUPPLY SO WE THOUGHT WE WOULD GO VISIT THE BREWERY. IT TOOK SOME SEARCHING BUT WE FOUND DAVE'S BREWFARM IN WILSON, WISCONSIN. HE MAKES MOSTLY BIG BEERS. EVERYTHING WE SAMPLED WAS EXCELLENT BUT MATACABRAS WAS THE BEST. ONE OF MY BUDDIES IS A SUBSCRIBER AND WE ARE HOPING THE REPLICATOR CAN HELP US FIGURE OUT HOW TO MAKE THIS BEER.

BARRY WHITE
ST. PAUL, MINNESOTA

The BrewFarm began in 2008 after owner/brewer David Anderson and his wife spent eight months looking for the ideal location. A 35-acre piece of farmland appealed to them because of the natural beauty and the constant wind. A 2200-square-foot brewery was constructed with an additional 1500-square-foot upper story for living space.

Anderson's goal was to make both the house and the brewery as self-sustaining as possible. In February 2009, he installed a 120-foot tower with a 20-kilowatt wind generator, which supplies more than enough electricity leading to his claim of "wind-brewed beer." Exterior walls are a foot thick and the facility is heated and cooled with geothermal energy. A massive hop garden, with 180 mounds, supplies plenty of hops for his fresh hop beers each fall.

Dave began homebrewing in 1992 and was immediately hooked on the process. After attending the Siebel Institute in Chicago he knew that a commercial operation had to be in his future. Now, he routinely produces eight to ten different beers on a 10-gallon (38-L) pilot system and a used 7-barrel system.

Matacabras' name means "goat killer" in reference to a legendary north wind in Spain that is so strong it is famous for killing goats. It doesn't fit any particular style, but Dave describes it as a Belgian strong hybrid. A creamy, bright white head tops a beer that is light amber with orange hues. He plans his recipes around the yeast strain, and the rye malt combines with this Belgian trappist strain to produce a distinct spiciness. He says that the higher fermentation temperature helps to accentuate the esters produced by this yeast.

Now Barry, no more searching for Matacabras because you can "Brew Your Own." For further information about the brewery visit their blog at www.davesbrewfarm.blogspot.com or call them at 612-432-8130. BYO

### Dave's BrewFarm Matacabras Ale clone

**(5 gallons/19 L, extract with grain)**

OG = 1.072 FG = 1.014 IBU = 31 SRM = 17 ABV = 7.6 %

**Ingredients**

6.6 lbs. (3 kg) Briess light, unhopped, malt extract
0.25 lbs. (0.11 kg) light dry malt extract
1.75 lbs. (0.79 kg) rye malt
1.25 lbs. (0.56 kg) special B malt (120 °L)
1.25 lbs. (0.79 kg) dark brown sugar (last 5 minutes of the boil)
6 AAU Centennial pellet hops (60 min.) (0.75 oz./21 g of 8 % alpha acid)
3.9 AAU Perle pellet hops (30 min.) (0.5 oz./14 g of 7.8% alpha acid)
4.3 AAU Amarillo pellet hops (15 min.) (0.5 oz./14 g of 8.6% alpha acid)
½ Tsp. Yeast nutrient (last 15 minutes of the boil)
Wyeast 3787 (Trappist Ale) or White Labs WLP 500 (Trappist Ale ) yeast
0.75 cup (150g) of corn sugar for priming (if bottling)

**Step by Step**

Steep the crushed grain in 1.5 gallons (5.7 L) of water at 152 °F (66.7 °C) for 30 minutes. Remove grains from the wort and rinse with 2 quarts (1.8 L) of hot water. Add the liquid and dry malt extracts and bring to a boil. While boiling, add the hops, yeast nutrient and dark brown sugar as per the schedule. During the boil, use this time to thoroughly sanitize a fermenter. Now add the wort to 2 gallons (7.6 L) of cold water in the sanitized fermenter and top with cold water up to 5 gallons (19 L).

Cool the wort to 80 °F (26.7 °C). Pitch your yeast and aerate the wort heavily. Allow the beer to cool to 75 °F (23.9 °C). Hold at that temperature until fermentation is complete. Transfer to a carboy, avoiding any splashing to prevent aerating the beer. Allow the beer to condition for 1 week and then bottle or keg. Allow the beer to carbonate and age for two weeks and enjoy your Matacabras Ale clone.

**All-grain option:**

This is a single step infusion mash using 10.5 lbs. (4.76 kg) of 2-row pale malt to replace the malt extracts. Mix the crushed grains with 3.75 gallons (14 L) of 170 °F (76.7 °C) water to stabilize at 152 °F (66.7 °C) for 60 minutes. Sparge slowly with 175 °F (79 °C) water. Collect approximately 6 gallons (23 L) of wort runoff to boil for 60 minutes. Reduce the 60 minute hop addition to 0.5 oz. (14 g) Centennial hop pellets to allow for the higher utilization factor of a full wort boil. The remainder of this recipe is the same as the extract with grain recipe.

# Oktoberfest

## Brew now, drink later

by Betsy Parks

CREDIT GERMANY FOR PLANNING AHEAD. TRADITIONAL MÄRZEN IS BREWED IN THE LATE WINTER AND EARLY SPRING MONTHS TO BE ENJOYED IN BEER GARDENS IN THE FALL. IN THIS ISSUE, THREE BREWERS DISCUSS WHAT IT TAKES TO BREW THE BEST OKTOBERFEST.

At Duck-Rabbit, we brew a traditional Märzen. When I formulated the recipe, I wanted a soft malt character. The malt is dominant, but think of it as a subtle bready flavor — it's not going to knock you over the head like a doppelbock. It is soft, round, light bodied and has some toasty characters, which come from using Munich malt.

I like to use a lot of Munich malt in this style — about 50% of the total grain bill, and I use domestic Munich malt. I use domestic malt, unless I can't get something domestically, because I'm an American brewer and I use American products as much as I can. Our Munich is a 2-row variety, which is what you would find in European malt.

We use a lager yeast strain for our Märzen. I want something that is going to be very clean and crisp, but doesn't ferment out too dry because I want some residual malt characteristics. I also want a yeast that does well at relatively low temperatures. Pitch cool and pitch heavy. We typically aim for around 53 °F (12 °C) and ferment for around two weeks. We try to leave it in the tank for lagering for a good seven weeks.

If you are thinking of brewing this style, understand the beer before brewing it. You're not trying to make a malt bomb. You want something crisp and delicate without being too light in body.

Paul Philippon, Founder and Brewer at The Duck-Rabbit Craft Brewery in Farmville, North Carolina. Known as "the dark beer specialists," Duck-Rabbit has earned critical acclaim since the brewery opened in 2004.

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At August Schell, we brew a traditional Märzen. As a 150-year-old lager brewery that specializes in German beers, no other styles were considered.

As with all our beers, the most important characteristic with this style is a sense of balance. Of course, when talking about different styles of beer, the balance is not always the same. For an Oktoberfest, you want to balance the hops with the malt to prevent the beer from being overly cloying, yet without interfering with the bready flavors of the style.

For malt, we use a blend of two-row, Munich malt, and caramel 40. We ferment our Oktoberfest with one of our house lager strains, which is a descendant of the Christian Schmidt strain. At home, I would recommend any of the various German lager strains that are available from commercial yeast vendors. Always follow the temperature recommendations that come with your yeast. We ferment our beer at 54 °F (12 °C), which is within the range for our yeast. Some lager strains prefer a cooler temperature than ours. Our lagering time is four weeks.

I would recommend sticking to Noble hop varieties (Hallertau, Tettnang, etc) or their new world hybrids (Liberty, Mt. Hood, etc). I prefer hops that exhibit a more flowery, spicy character.

As with brewing any lager, temperature control is critical. Carefully consider all your ingredients, and keep in mind that sometimes less is more. It's not about making the biggest beer out there, it's about making the one that is the most pleasurable to drink.

David Berg (left), Assistant Brewmaster at August Schell Brewing Co. in New Ulm, Minnesota. David graduated from the American Brewers Guild Craft Brewer's Apprenticeship Program in 1996. He has been the Assistant Brewmaster at August Schell since 2006.

Todd Charbonneau, Head Brewer at Harpoon Brewery in Boston, Massachusetts and Windsor, Vermont. Todd attended the Master Brewers Association of the Americas short course in Malting and Brewing Science. He joined Harpoon in 2001.

Harpoon's Oktoberfest is modeled more after the old style of Märzen, which had much more color and body than the Oktoberfests that are now served at the annual Munich Oktoberfest. Above those attributes, ours is certainly a far sight more bitter and hop flavored than the style calls for. We can't resist hops.

After a summer of lighter, more quenching styles, I love the bready, malty body of our Oktoberfest combined with the nice spicy hop flavor. The beer should be fairly clean with low esters to let those characteristics shine through.

Our Oktoberfest is 14.5 °P OG, 5.3% ABV with an IBU of 50. It has a fairly low gravity and ABV for long sessions, along with some pretty aggressive bitterness to balance the solid malt body, then capped off with a gorgeous garnet color.

We use dark and light colored Munich malts along with a bit of Chocolate malt and of course, pale malt. We ferment it with our house yeast at fairly low temperatures to discourage the production of fruity esters, which are undesirable in the style. Ale yeast fermentations are best done at the low end of their temperature range to discourage ester formation and leave the beer clean and malty. Lager yeast are more appropriate for the style but not always used. Long, cold maturation periods help to enhance that clean malty character.

The beer is bittered with Willamette and finished with liberal amounts of US Tettnang hops, a variety prized for its spicy, herbal character.

Again, use yeasts that can tolerate cool fermentations and crash cool the beer for as long as possible after fermentation is complete. Choose German "noble" hop varieties for authenticity. Don't make the beer too big. Remember that this is designed as a session beer with fairly low ABV. Use a moderately high mash temp for residual body and sweetness. Allow lots of time to settle the yeast after fermentation to achieve a mellow, clean and bright finished product. Enjoy it out of 1-liter mugs! BYO

# Carbonation Space

## Grain mills, plate chillers, lagering

by Ashton Lewis

**Q** SOME CLAIM THAT HEADSPACE IN A BOTTLE AFFECTS THE RATE AND DEGREE OF CARBONATION WHEN USING PRIMING SUGAR. ESSENTIALLY, "THE MORE HEAD SPACE, THE MORE CARBONATION." I WOULD ASSUME THAT ALL PRIMING SUGAR IS CONSUMED BY YEAST IN THE BOTTLE, AND THAT MORE HEADSPACE WOULD ACTUALLY RESULT IN LESS CARBONATION, SINCE MORE OF THE $CO_2$ PRODUCED WILL GO INTO THE HEADSPACE INSTEAD OF THE BEER. SOME SUGGEST THAT THE OXYGEN IN HEADSPACE ALLOWS THE RESIDUAL YEAST TO REPRODUCE PRIOR TO FEEDING ON THE SUGAR, THUS MORE QUICKLY AND MORE COMPLETELY CONSUMING THE SUGAR. ANOTHER SUGGESTION IS, WITH LESS (OR ZERO) HEADSPACE, PRESSURE INSIDE THE BOTTLE SHOULD INCREASE MORE QUICKLY, SINCE LIQUIDS ARE RELATIVELY INCOMPRESSIBLE. ALL OTHER FACTORS BEING EQUAL, DOES A FIXED AMOUNT OF PRIMING CORN SUGAR RESULT IN A DIFFERENT CARBONATION LEVEL IN THE BEER IF THE HEAD SPACE IN THE BOTTLE IS DIFFERENT?

JAMES L. MACHIN
AUSTIN, TEXAS

**A** When beer is primed and bottled for the purpose of carbonation there is but one objective — and that is to produce carbon dioxide from the priming sugar by fermentation. The carbon dioxide will dissolve in the beer and is then released when the bottle is opened. Inevitably there is some headspace when beer is bottled because of the displacement of the filler tube inserted into the bottle during filling. As a bottle of beer becomes carbonated, or "comes into condition," some of the carbon dioxide dissolves into the beer and some of the carbon dioxide pressurizes the headspace because of the equilibrium that always exists between dissolved gases in liquid and the partial pressure of the same gas in the atmosphere above the liquid.

Understanding gas equilibria in liquids is the key to this question. Without getting into the mathematics of the topic, I will briefly summarize some relevant facts. A bottle of beer with a small headspace at a fixed pressure, say 15 PSI, contains fewer molecules of carbon dioxide in the headspace than does a bottle with a larger headspace at the same pressure. The goal of carbonation is not pressurizing the bottle headspace, rather it is dissolving gas into the beer.

As an example, imagine that you are inside a 10,000-gallon (37,854-L) beer tank. After taking in the immense size of this big beer tank you crawl out of the tank, pour a 5-gallon (19-L) bottling bucket of homebrew along with a normal amount of priming sugar, about ⅔ cup, into this giant beer tank and seal the tank up. Will the beer ever be carbonated? No. Why? Because the volume of the tank is so big that it requires almost 15,000 pounds (6,800 kg) of carbon dioxide to pressure the tank high enough to carbonate the 5 gallons (19 L) of beer. In this example almost all of the carbon dioxide required to carbonate the beer is really required simply to pressurize the tank. While extreme, this exemplifies the effect of headspace volume on pressure.

In summary, the volume of headspace does matter, and it affects the carbonation the way you describe. The idea that the yeast may metabolize the sugar via aerobic respiration, versus fermentation (anaerobically), and thereby produce more carbon dioxide is interesting. However, yeasts require developed mitochondria for aerobic metabolism, which are not found in brewer's yeast.

Add priming sugar to your bottling bucket based on the volume of beer you are bottling and then fill your bottles to a consistent level in an attempt to minimize bottle-to-bottle variation associated with varying headspace volumes.

"The goal of carbonation is not pressurizing the bottle headspace, rather it is dissolving gas into the beer."

# Q

I AM A TOOL AND DIE MAKER AND I RECENTLY BUILT A GRAIN MILL AT WORK. I MADE IT FOR SETTINGS FROM 0 TO 0.080-INCH AND RAN TEST SAMPLES WITH RICE. WHAT DO YOU THINK WOULD BE THE BEST SETTING FOR MILLING MALT FOR AN ALL-GRAIN BREW?

JOHN
HONEY BROOK, PENNSYLVANIA

# A

The test you ran using rice is helpful because it indicates that your mill works to reduce particle size. When using a mill of any type, the best way to determine the gap setting for various grains is to run test crushes. This is a very common practice in most commercial breweries.

As with most things in a brewery the "best" assortment is determined empirically. In general, a coarse grist works well for homebrewing since more specialized wort separation devices, such as lauter tuns with rakes or mash filters, are not used at home; lauter tuns and mash filters typically use finer grist and they produce better extract yield than infusion mash tuns.

A good starting point for malt milling is to use a roller gap of about 0.040-inch or a hair greater than 1-mm. When malt is milled you want to see intact husk pieces because the husk is what comprises the filter bed that is so important for wort clarification. But there is a balance between too coarse and too fine — after all, you do want to mill the grain. So in addition to nice pieces of intact husk you also want to see little chunks of white endosperm, or the starchy middle of the malt kernels. The endosperm is the source of starch that is converted into fermentable sugars during mashing. You will also see smaller pieces of endosperm along with yet finer flour particles mixed in with the grist. This is all to be expected and the only way to know that you got it right is to use your grist for test batches of homebrew.

If the grist is too fine the most likely problem you will encounter is difficulty with wort separation. If the grist is too coarse you will have a lower yield than expected. Over time you will be able to tune your mill to provide a reasonable extract yield using grist that does not give you headaches with wort collection. Enjoy your home-built malt mill!

**Q** I AM MAKING A CLASSIC STYLE PILSNER AND WAS WONDERING HOW LONG I CAN LAGER THE BEER IN THE SECONDARY FERMENTER AND IN THE BOTTLES? IS TWO MONTHS IN THE SECONDARY TOO LONG? SHOULD I CONDITION IT LONGER IN THE SECONDARY OR IN THE BOTTLES?

DAVE WOOD
VIA EMAIL

**A** I think this question probably will generate two very different answers depending upon who you ask. In this case you asked me and will get my take on it. Let's back up . . . why lager beer at all? The most common reasons cited for lagering, or aging before serving, are diacetyl reduction, acetaldehyde reduction, clarification and carbonation.

Some folks talk about flavor maturation, flavor mellowing and beer stabilization when they talk about lagering, but these are all different terms for the four objectives I cited. The only thing that should be performed before bottling is clarification, and this only needs to be done partially since yeast is needed for bottle conditioning and the bottle bottom serves reasonably well to keep yeast sediment out of the beer, provided that some care is exercised when moving bottles around and when the beer is poured.

I suggest fermenting your lager until the final gravity is stabilized and then allowing it to sit at the fermentation temperature for a few days to give the diacetyl and acetaldehyde reduction steps a solid head start, if not more than enough time to be complete. Move the beer to a cold place, such as a refrigerator or snow bank for about a week. The cold temperature will knock a lot of the yeast out of solution and make racking easier prior to bottling. I then would rack, prime and bottle.

If you want to hold your Pilsner for a couple of months prior to drinking I would suggest the hold step after bottling because the bottle has everything you need for lagering; yeast, beer, fermentable sugars and a mechanism to hold the carbon dioxide in the container (the bottle cap). This is of course not traditional for lagers. Most lagers brewed in the old days, which is what brewers often reference when discussing "traditional" methods, were aged in large tanks or barrels and then moved into smaller barrels where they would be transported to the tavern for serving.

**Q** I HAVE BEEN THINKING OF BUYING A PLATE CHILLER FOR THE LAST YEAR FOR A FEW REASONS: 1) IT TAKES LESS TIME TO CHILL THE WORT THAN MY CURRENT COPPER WORT CHILLER, AND 2) IT USES LESS WATER. SO I BELIEVE THERE ARE TWO MAIN OPTIONS WHEN BUYING ONE; EITHER A CLOSED PLATE CHILLER WHICH CANNOT BE TAKEN APART OR A DESIGN THAT CAN. WHAT ARE THE UPS AND DOWNS OF THE TWO AND HOW DO YOU GO ABOUT CLEANING THEM TO ENSURE THE PRECIOUS WORT IS BUG FREE?

ROSSA O'NEIL
DUBLIN, IRELAND

**A** This is a good question in that there is not a single answer. The company that puts bread on my table manufactures plate heat exchangers, among many other things stainless, and we also use brazed plate heat exchangers for certain purposes in some of the processing systems we manufacture. In heat exchanger lingo a plate heat exchanger, often referred to simply as a PHE, is made of plates where the cooling or heating medium is on one side of the plate and the product is on the opposite. In many applications it is desirable to be able to dissemble the PHE for maintenance, inspection and/or cleaning. When this functionality is required the units are bolted together and the plates separated by gaskets.

Another type of PHE is the brazed plate heat exchanger. These are typically used where disassembly is not required or the added cost required to make the unit serviceable is not worth the money. Brazed PHEs are normally used for simple utility duties where there is not "clean" product involved. For example, if you want to heat water with steam and use the hot water in a secondary heating application the brazed PHE is a decent choice.

When our customers are heating or cooling a food product, a PHE designed to be disassembled is the go-to heat exchanger. Typical examples include wort cooling, beer cooling, wine attemperation, hot water production using steam, solution heating in CIP (clean-in-place) systems and flash pasteurization units.

Brazed plate heat exchangers are cheaper, however, the problem with the brazed PHE is that you cannot disassemble the unit and this makes some people uncomfortable. On the other hand, the brazed PHE has become quite popular for homebrewers because they are available in small sizes and they are priced to fit the homebrewing budget. While I would never sell one of these units to a commercial brewer for wort cooling, I would recommend them, with caution, to a homebrewer.

The biggest problem with PHEs in general is that solids can become trapped within the plate pack. When wort coolers collect solids things can be a problem because, as you state, microorganisms can (and do) grow. When this occurs the wort cooler becomes a wort contaminator.

So what is a homebrewer to do? If you have the funds and really don't mind spending the extra money, a small PHE designed to be taken apart is my first recommendation.

If you choose to purchase a brazed PHE I strongly advise putting some sort of coarse filter in front of the unit to trap bits of hops and trub. This can be something as simple as a section of stainless steel scrubby pad on the inlet of your wort siphon or on the outlet of your kettle if you have a valve.

After use I would clean the unit by thoroughly rinsing it with water and then I would "pack" the unit with a 2–3% solution of sodium hydroxide (commonly known as lye or caustic) or a less alkaline cleaner, such as Powdered Brewery Wash (PBW). Allow the cleaner to sit in the PHE for at least an hour before rinsing. This will help to remove protein soils that form films on stainless steel surfaces. As with all cleaners it is important to exercise caution at home. BYO

# Big and Belgian

## Belgian strong golden ale

by Jamil Zainasheff

Duvel is considered the ultimate example of Belgian strong golden ale and I think they also have the best description of the style on their bottle label. It reads, "Refreshing and golden like a Pilsner but with the flavor, depth and complexity of an ale." It continues with this advice, "Enjoy chilled (40 –50 °F/4–10 °C) with discerning friends or good-looking strangers."

I'm not sure about the "strangers" part, but Duvel is a great example of the style. It is golden, complex, effervescent, strong with a fruity start and a crisp, dry finish. Belgian strong golden ale ranges from 7.5 to 10% ABV with significant fruity esters, some spicy notes from fermentation (and sometimes hops), and subtle, warming alcohol notes supported by a delicate malt character. Good examples are crisp and dry with a moderately bitter balance. Carbonation is high and the body ranges from light to medium. Even though hops and malt play a role in the character of this beer style, fermentation is really the centerpiece.

One thing to keep in mind, while Belgian strong golden ale has a higher than average alcohol concentration, that does not mean it should be hot or solvent-like. Hot or solvent is never an appropriate beer character regardless of its alcoholic strength. The alcohol should be subtle and warming.

The base malt for this style is continental Pilsner malt. Pilsner malt lends a slightly sweet, grainy malt character to the beer. If you can source it, Belgian Pilsner malt is ideal. If you cannot, do not worry, even the Belgian brewers use other continental Pilsner malts. If you are an extract brewer, try to use an extract made from Pilsner malt. While it may seem like it isn't worth the trouble, a beer like this does not have a lot of specialty malts to hide behind, so it is important to use a good quality Pilsner malt extract. Pilsner malt and some table sugar is all you need. While you might find recipes with oats, wheat, CaraPils®, aromatic, Vienna, Munich, crystal malts and more, it really isn't the way to go. Specialty malts in this case (especially crystal malts) tend to make the beer heavier and fight the crisp, dry character that you are trying to achieve.

I prefer to keep it simple and stick with just base malt and sugar. If you are going to experiment, focus on the grainy/bready malt flavors (such as biscuit, aromatic, Vienna or Munich) and not the sweet ones (crystal/caramel malts). In any case, do not add more than 3% of any specialty malt. If you can taste the specialty malt in the beer, it is too much.

Since this is a bigger beer with high starting gravities, all-grain brewers should target a mash temperature around 149 °F (65 °C). For extract brewers, most light colored extracts are not fermentable enough on their own, but with a portion of simple sugar (table sugar), it should attenuate enough. You will still want to buy an extract that attenuates well or you will need to make your extract-based wort more fermentable by replacing more of the extract with table or corn sugar. When all-grain brewing you can use up to 20% of the grist weight as table sugar (the percentage by weight is higher when brewing with extract, as much as 30% of the weight when using DME) with good results. There is no need to use special sugars.

The dryness and firm bittering of a good Belgian strong golden ale comes from alcohols, phenols, carbonation and hops. I prefer to stick with noble hops such as Saaz, Hallertau, or Tettnang. Traditionally, breweries also use Styrian Goldings and in a pinch other varieties such as Mount Hood, Liberty or Kent Goldings are fine as well. I prefer a single large charge of low alpha hops near the beginning of the boil. With the light malt character, the flavor of that early addition will carry through and will provide a subtle

### belgian strong golden ale by the numbers

| | |
|---|---|
| **OG:** | 1.070–1.095 (17.1–22.7 °P) |
| **FG:** | 1.005–1.016 (1.3–4.1 °P) |
| **SRM:** | 3–6 |
| **IBU:** | 22–35 |
| **ABV:** | 7.5–10.5% |

Photo by Charles A. Parker/Images Plus

## Belgian Strong Golden Ale

**(5 gallons/19 L, all-grain)**
OG = 1.072 (17.5 °P)
FG: = 1.007 (1.9 °P)
IBU = 32 SRM = 3 ABV = 8.5%

### Ingredients

9.92 lb. (4.5 kg) Continental Pilsner malt (Durst or similar) (~1.6 °L)
2.47 lb. (1.12 kg) cane or beet sugar
6.5 AAU Czech Saaz pellet hops (1.87 oz./53 g of 3.5% alpha acids) (90 min.)
White Labs WLP570 (Belgian Golden Ale) or Wyeast 1388 (Belgian Strong Ale) yeast

### Step by Step

Mill the grains and dough-in targeting a mash of around 1.5 quarts of water to 1 pound of grain (a liquor-to-grist ratio of about 3:1 by weight) and a temperature of 149 °F (65 °C). Hold the mash at 149 °F (65 °C) until enzymatic conversion is complete. With the low mash temperature, you may need to lengthen the rest time to 90 minutes or more to get full conversion. Infuse the mash with near boiling water while stirring or with a recirculating mash system raise the temperature to mash out at 168 °F (76 °C). Sparge slowly with 170 °F (77 °C) water, collecting wort until the pre-boil kettle volume is around 6.5 gallons (24.4 L) and the gravity is 1.056 (13.7 °P).

The total wort boil time is 90 minutes, which helps reduce the S-Methyl Methiomine (SMM) present in the lightly kilned Pilsner malt and results in less Dimethyl sulfide (DMS) in the finished beer. Once the wort is boiling, add the bittering hops. Add the sugar and Irish moss or other kettle finings with 15 minutes left in the boil. Chill the wort rapidly to 64 °F (18 °C), let the break material settle, rack to the fermenter, pitch the yeast and aerate thoroughly.

You will need three packages of liquid yeast or you can make a 4L starter from 1 package. Pitch yeast at 64 °F (18 °C), aerate or oxygenate, and let the temperature rise slowly to 82 °F (28 °C) over the course of one week. Ferment until the yeast drops clear. With healthy yeast, fermentation should be complete in a week, but do not rush it. It is important for the beer to attenuate fully. When finished, carbonate the beer to approximately 4 volumes and serve at 45 to 50 °F (7 to 10 °C).

If you have trouble getting enough attenuation in big beers, you can hold off on adding the sugar to the boil. Instead, after the fermentation looks like it has started to slow, mix the sugar with just enough boiling water to make a syrup, then add that to the fermentation.

## Belgian Strong Golden Ale

**(5 gallons/19 L, extract)**
OG = 1.072 (17.5 °P)
FG = 1.007 (1.9 °P)
IBU = 32 SRM = 3 ABV = 8.5%

### Ingredients

7 lb. (3.18 kg) Pilsner liquid malt extract (~2.3 °L)
2.47 lbs. (1.12 kg) cane or beet sugar
6.5 AAU Czech Saaz pellet hops (1.87 oz./53 g of 3.5% alpha acids) (90 min.)
White Labs WLP570 (Belgian Golden Ale) or Wyeast 1388 (Belgian Strong Ale) yeast

### Step by Step

Mix the malt extract with enough warm water to make a pre-boil volume of 6.5 gallons (24.4 L) and a gravity of 1.056 (13.7 °P). Stir thoroughly to dissolve the extract. Bring to a boil. Once the wort is boiling, add the bittering hops. The total wort boil time is 90 minutes. Add the sugar and Irish moss or other kettle finings with 15 minutes left in the boil. Chill the wort rapidly to 64 °F (18 °C), let the break material settle, rack to the fermenter, pitch the yeast and aerate thoroughly. Follow the remaining instructions for the all-grain version.

hop character. Nowadays more brewers are experimenting with increased hop character in these beers, but it takes a deft hand to avoid overdoing it. A single, small addition near the end of the boil is about all you should add if you still want to consider the beer a "traditional" example. If you go with much more than that, you might find some judges marking you down in competition for excessive hop character. The bitterness-to-starting gravity ratio (IBU divided by OG) ranges between 0.25 and 0.5, although most brewers will want to target approximately 0.4 unless you are getting a very dry finish from fermentation.

The characteristic fruity/spicy flavors and aromas of this style come from fermentation, not from the addition of fruits or spices. While some brewers may add spices, the problem is that spices will never really take the place of proper fermentation. The subtle complexity that comes from fermentation can't really be faked by spice additions. It is better to focus on perfecting fermentation.

There are several great yeast strains for brewing this style, but two of my favorites are White Labs WLP570 Belgian Golden Ale and Wyeast 1388 Belgian Strong Ale. Other excellent choices are White Labs WLP500 Trappist Ale, WLP540 Abbey IV Ale Yeast, WLP550 Belgian Ale Yeast, Wyeast 3787 Trappist High Gravity and Wyeast 1214 Belgian Abbey. You cannot go wrong with any of these yeast strains. When selecting yeast, keep in mind that this style is more about the fruity notes than spicy phenols. Whatever strain you use, remember that your fermentation conditions affect what flavors and aromas the yeast produce. Pitching rate, oxygen level, nutrients, and temperature are like dials on your control panel of fermentation flavor. Getting the right settings is your job as a brewer.

One question that many brewers have about Belgian beers is fermentation temperature. Often homebrewers will say, "Brewery X ferments their beer at xx °F, so that is the fermentation temperature I use." That most likely won't be the right temperature for you if you are trying to make a beer like theirs. There are many other factors than temperatures. For example, fermenter height plays a role in flavor development, with very tall fermenters (like big commercial cylindroconical types) suppressing ester and fusel alcohol production. The shape of the brewery's fermenters, their pitching rates, their oxygen levels, their yeast collection and repitching methods may all be different than yours, changing the production of esters, fusel alcohols and other aspects of fermentation. When you use the same fermentation temperature in your brewery with disregard for the other parameters, you may end up with fruit salad dissolved in paint thinner. Well, maybe not that bad, but pretty darn close. Do not let "how the classic brewery does it" determine your process unless you are using the same equipment and methods. Instead, get to know the beer style intimately and work on adjusting your process until you are making an outstanding example. It might take many tries and a vastly different process for you to achieve those results, but that is the fun of homebrewing.

With most of these yeasts I recommend pitching at a rate of 0.75 million cells per milliliter per degree Plato (see the pitching rate calculator at www.mrmalty.com for help in calculating this for your beer). Pitch the yeast and allow 12 to 36 hours for the majority of yeast growth, then ramp up the temperature for the rest of fermentation to ensure good attenuation. For example, pitch the yeast at 64 °F (18 °C) and at the end of the next day slowly begin raising the temperature each day. Try to end up at 82 °F (28 °C) by the end of one week. You may find a higher or lower temperature or a faster or slower rise in temperature gives you the ideal result, so do not be afraid to tweak the parameters until you get it right.

One concern when brewing this style is getting enough attenuation. Many brewers go with lower and lower mash temperatures in an attempt to achieve this, but that is not always the problem. It isn't that you need to get rid of all of the long chain dextrins to make a dry beer. Those dextrins are not very sweet and they can be present in a nice, dry beer. The important thing is to make sure you ferment out all of the simpler sugars completely. If you leave a lot of unfermented maltose, then the beer is going to taste sweet, even though it might attenuate well. Starting with a healthy pitch of yeast, aerating or oxygenating, and controlling temperatures, are the keys to getting a dry finish.

Oxygen is important to yeast health and is necessary for fermentation to reach terminal gravity in a reasonable amount of time. However, too much or too little oxygen can have unintended consequences, so adding the right amount of oxygen is important. That is difficult for many homebrewers, but you should try to control the amount of oxygen added by measuring timing and flow rate. The amount of oxygen required is a balancing act and can result in excessively high or low esters and fusel alcohols. If you are using air, there is no chance of over-aerating your wort, but there is a chance of under-aerating. If you are using oxygen with a sintered stone, a good starting point for 5 US gallons (19 L) is a flow of 1 L per minute for 1 minute. If you find yourself getting stuck fermentations when brewing high gravity beers, you can add a second dose of oxygen between 12 and 18 hours after pitching. The second dose should be about ½ to ¾ the normal amount of oxygen. This will give the yeast the ability to rebuild their cell membranes after having replicated. They will better tolerate the high alcohol environment ahead with this additional dose of oxygen.



If you are having trouble getting a dry beer, one trick that seems to help is waiting until the fermentation is nearly done before adding the simple sugars. Wait until fermentation has started to slow and then add the sugar. Adding the sugar after the yeast have consumed the maltose is like telling your kids to finish their dinner before they can have dessert. When I do this I dissolve the sugar in just enough boiling water to make a thick syrup. Once it cools, I add it to the beer.

If all else fails and you still are not getting full attenuation, you can pitch an actively fermenting lager yeast into the stuck beer, which will consume some complex sugars that the ale yeast will not. Do not add this extra dose of yeast if they are not in an active fermentation state, because they will just settle out in a high alcohol, low sugar environment. Make a small starter and wait until the yeast are at high kräusen before you add it to the beer.

If your beer is attenuating properly but still tastes sweeter than it should, it might be fermentation related compounds that are making it seem sweet. If that is the case, then you need to revisit your fermentation parameters and/or try a different yeast strain. BYO

*Jamil Zainasheff writes "Style Profile" in every issue of* BYO.

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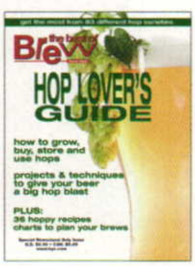


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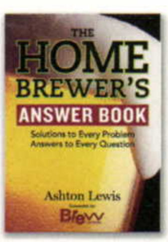


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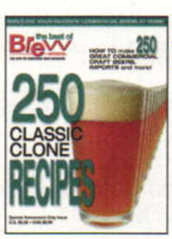


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Story and photos by **Sean Z. Paxton**

I

If asked where a beer gets most of its flavor, many will answer that it comes from the malt and the hops. Many forget the role yeast plays in a beer's flavor and aroma. The Weihenstephan 68 yeast strain — available to homebrewers as Wyeast 3068 (Weihenstephan Weizen) or White Labs WLP300 (Hefeweizen Ale) — produces a wonderful balance between banana esters and clove phenols. Understanding this yeast strain and using it as a flavor tool, will enhance the sweet and spicy characteristic components found in this beer style. These same yeast-derived flavors can also be used when cooking with German-style wheat beers.

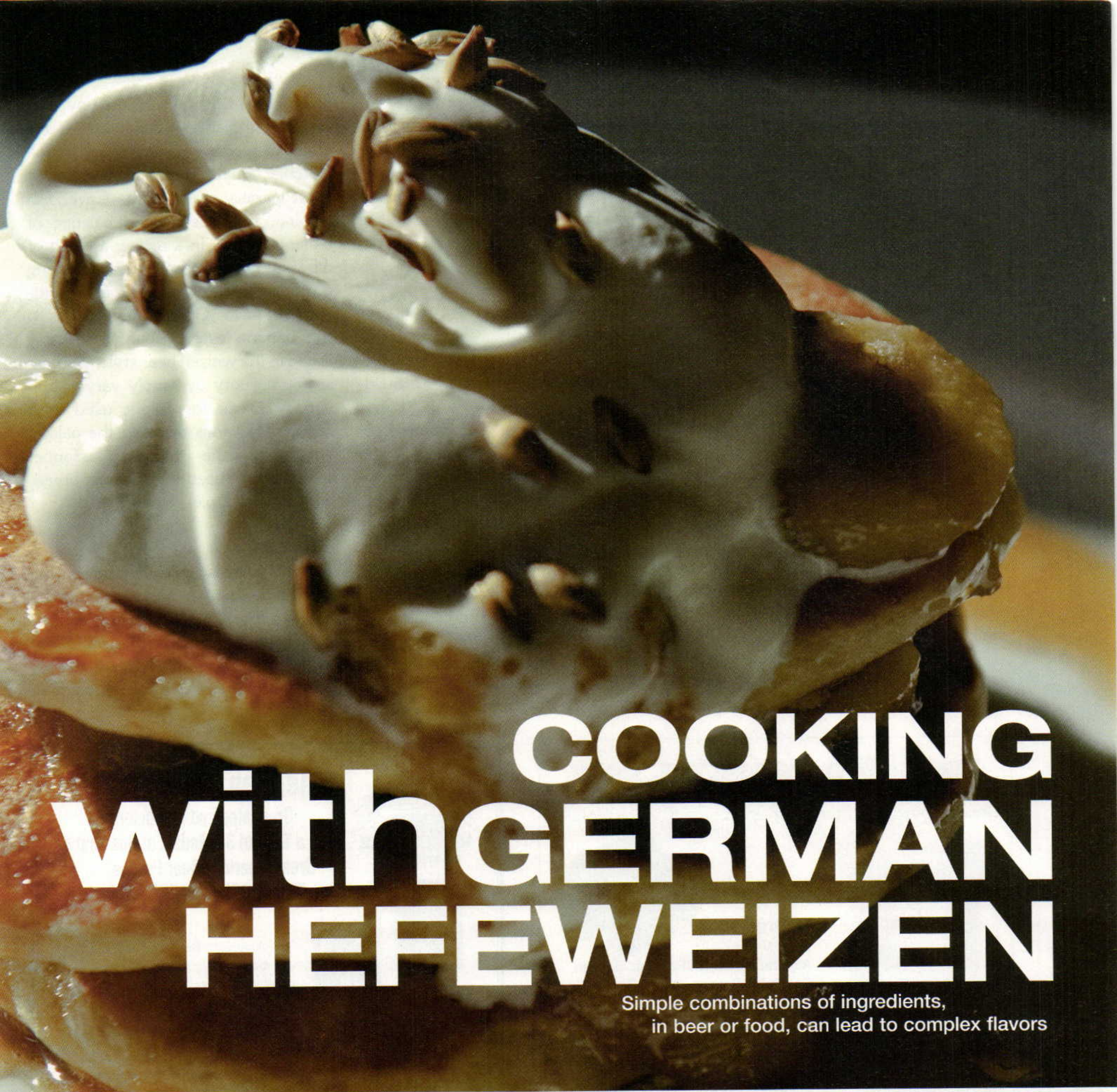
The malt bill of a weizen recipe is very simple, usually equal parts barley and wheat malt. There isn't much to hide behind; no highly-kilned, caramelized or roasted malts that commonly add complexity with layers of flavor found in many other beer styles. With a clean canvas of simple flavors from Pilsner and wheat malt, this style needs a yeast that adds its own personality to the final brew. If we think carefully about the importance of the mashing of these grains, we can actually get more depth of flavor in the beer. By introducing a temperature or decoction step into the mash at 110 °F (43 °C) for fifteen minutes, the level of ferulic acid is increased in the wort. This simple addition to the brew day creates a precursor that when consumed by the yeast, will produce more phenolic attributes in the final flavor profile. (The ferulic acid gets converted to 4-vinyl-guaiacol, the source of clove-like flavors in weizens.)

The banana flavors from the yeast (which come from the ester isoamyl acetate) can also be controlled and adjusted. Lower pitching rates and higher fermentation temperatures favor the production of this molecule in strains fermented with a German wheat yeast. German weizen strains can be top cropped to gather yeast for your next beer. However, most homebrewers use a new pitch of a German wheat strain for fermentation. (See Jamil Zainasheff's article "German Hefeweizen," in the

Pictured: Hefeweizen Pancakes with Caramelized Bananas and Clove Scented Whipped Cream

Bottom row, from left to right:

Hefeweizen Pancakes
Caramelized Bananas in Weizen Syrup
Hefeweizen Masa
Indian Tamale



# COOKING with GERMAN HEFEWEIZEN

Simple combinations of ingredients, in beer or food, can lead to complex flavors




January-February 2011 issue of *BYO* for more details on brewing a German-style wheat beer.)

### From Brewing to Cooking

It is essential when cooking with beer, to understand the beer style being used in the dish. When the flavor profile in a weizen is examined, elements of sweetness with a undertone of vanilla, soft grainy wheat or bread essence, along with a slightly sweet malt finish will be evident to the taster. The fruity banana esters, along with a slight bubblegum taste combine with an almost citrusy yeasty element on the palate. Because the hopping rate in this style is so low, substantial hop flavor and aroma is absent. However, the balancing bitterness is apparent next to the malt component. This information can help the cook or chef understand the possibilities of how to use a beer from this style in cooking.

When thinking about flavor, the bandwidth of the palate can be expanded by building elements of a flavor into a dish. With the recipes below, the weizen style is showcased as a key flavor contributor. The banana ester (isoamyl acetate) flavor is a dominating component in some examples of this beer style, motivating a chef to think about how to play with this flavor.

### Bananas

Understanding that there are six commercial varieties of bananas available to the consumer is one way to build this flavor profile in a dish. Baby bananas have a sweet, richer and more intense banana flavor when ripe. A red banana has more beta carotene from the color of its peel, giving a soft raspberry essence and also more vitamin C. The manzano banana is smaller than the common Cavendish banana, but has a lot of tropical flavors like pineapple, papaya and some apple and strawberry notes rounding out the sweetness. The burro banana has notes of lemon, with an almost citrusy finish along with a very creamy texture. The plantain banana is much lower in sugar, making this banana starchier. Finally, the banana we find at most grocery stores is the Cavendish banana, that has a good balance of banana flavors. In a recipe, a blend of different bananas can be used, creating a more complex seasoning and bandwidth of flavor. Complementing this to the banana ester (isoamyl acetate) found in the weizen beer style, will create complexity by simply varying the variety of an ingredient used in a recipe. This adds more to the palate, enhancing the banana essence, whether it is used in a banana bread, pudding, cake, pie, or pancake.

### Cloves

From Madagascar to Vietnam, the tropical evergreen tree in the myrtacease family produces a unique flower bud, which is the source of what are commonly called cloves. These immature blossoms are ready to be picked when they turn an intense red crimson color, then laid out to dry. When fully dried, these dark brown nail-like buds are used as a spice in East Asian cuisines. Used sparingly, whole and in ground form, cloves give a very strong fragrance to any dish. In India, cloves are added to the spice blend garam masala as well as chai masala, giving deepness when mixed with cinnamon, cumin and cardamom pods. In the West, cloves are also mixed with mulling spices, pickling spices and even found in cigarettes. Designing a pairing with the zing of cloves, whether it be in a beer or in a food dish, one can think about the complementary seasonings mentioned above. Using a German weizen with Indian cuisine becomes a natural extension of flavor attributes found in the beer style and cuisine profile. When arranging the elements of flavor with a dish, overlaying the type of preparation, then influencing the cuisine's natural core, created one of the recipes on page 30: the Indian tamale. By adding the acidity of lemon, one extends the common slice on the rim of a Bavarian weizen glass.

If you were seeking to pair a German weizen with cheese, one might suggest many from the goat family. With the goats milk being tart and having the creamy fat to suppress some of the citrus acid notes, a fresh chève, Cypress Grove Humboldt Fog, goat brie or a goat-style gouda would offer an elegant pairing. For an entrée, a clove-studded baked ham, Indian curries, Chinese five spice flavored dishes or traditional Thanksgiving fare would pair well. When dessert is offered to the dinner, think a gingerbread, baked apple or pumpkin pie matched with a German weizen.

The recipes on page 30 and 31 were inspired by the flavors in German-style hefeweizens. By embracing the style elements found in these Germanic wheat brews, the taster will be educated on the nuances that layer across the palate.

*This is Sean Paxton's (The Homebrew Chef's) second article for* Brew Your Own. *He has previously written about cooking with Baltic porter.*

# WEIZEN INSPIRED RECIPES

### Hefeweizen Pancakes with Caramelized Bananas Sprinkled with Crystal Malt, Clove Scented Whipping Cream and a German Weizen Syrup

*I can't think of a better way to start off a brew day. These hefeweizen pancakes are light, fluffy and full of flavor.*

Serves: 4–6 people

**Hefeweizen Pancake Ingredients:**

3 cups all-purpose flour
¼ cup dried Bavarian wheat malt extract or honey
2 teaspoons baking powder
1 teaspoon baking soda
½ teaspoon kosher salt
2 eggs (large, room temperature)
1½ cups buttermilk
12 ounces German wheat beer
4 tablespoons vegetable oil

**Caramelized Banana in German Weizen Syrup Ingredients:**

2 cups German weizen
1½ cups dried Bavarian wheat malt extract or honey
½ cup sugar
1 each lemon, peeled, leaving white pith behind
4 bananas (ripe but still firm, preferably organic, peeled and sliced)

**Clove Scented Whipping Ingredients:**

1 cup heavy cream
¼ cup dried Bavarian wheat malt extract, or honey
¼ teaspoon clove (ground)
½ cup crystal malt (70-80 °L, whole)

**Hefeweizen Pancake Directions:**

In a bowl, whisk together flour, wheat malt extract, baking powder, baking soda and salt. In another bowl, add egg whites and whisk to a soft peak. In another bowl, add the egg yolks, buttermilk, German weizen and oil; whisk to combine. Using a spatula, add the flour mixture to the beer liquid and fold in the egg whites. The batter should have small to medium lumps, do not over-mix.

Heat griddle to 375 °F (190 °C). Using either butter or oil, add a little onto the griddle. Using a ladle, add about ½ cup of batter to the griddle for each pancake. Space the pancakes about 2 inches apart, accounting for the spread factor. When the pancakes form bubbles around the edge of the pancake, and they just start to pop (about 2 ½ minutes) flip each with a spatula. Cook until golden on bottom, about 2 minutes. Repeat with remaining batter, keeping finished pancakes on a heatproof plate in oven set to 200 °F (93 °C). Serve warm.

**Caramelized Banana Directions:**

In a sauté pan placed over medium heat, add the beer, wheat malt extract, sugar and lemon peel/zest and bring to a boil, being careful of foaming, causing a boil over. Boil the syrup for about 15 minutes, until the liquid turns a nice light amber color. Just before adding the bananas, remove the lemon peel and keep for a garnish. Coat the bananas with the beer caramel using a large spoon and cook for 3–4 minutes, turning once. Turn off the heat and keep warm for service.

**Clove Scented Whipping Directions:**

In a medium sized mixing bowl, add the cream, wheat malt extract and clove. Using a whisk, beat the cream until it is light and fluffy, holding a peak, but not over whipped, making it grainy. Set aside.

**To Serve:**

Place 3-4 pancakes per plate and top or layer with the caramelized bananas, drizzling with the beer syrup, then top with the clove scented whipping cream and sprinkle with some of the crystal malt and some of the reserved candied lemon peel.

### Indian Tamale Hefeweizen Masa Dough Filled with a Banana Chicken Curry with Cashews Steamed in a Banana Leaf and Served with a Coconut Clove Sauce

*Infusing different cuisines with traditional techniques can offer creative approaches to food. Using a tamale as a wrapper for an Indian curry and tweaking the flavors to a beer style; the result is a new dish ready for the tasting that is specifically designed around the flavor of a beer.*

Makes: about 14–16 tamales, serving between 4–6 people

**Banana Chicken Curry Ingredients:**

¼ cup ghee or vegetable oil
1 teaspoon mustard seed, black
1 teaspoon coriander seeds, whole
2 onions (yellow, peeled and sliced thin) (about 5 cups)
1 tablespoon ginger (peeled and minced fine)
2 teaspoons garam masala spice blend
¼–1 teaspoon cayenne or other chili powder, depending on hotness desired
6 chicken thighs (boneless and skinless, cut into ½ cubes)
1 tablespoon kosher salt
½ cup cashews (lightly roasted and chopped)
½ cup coconut (unsweetened, flaked)
3 bananas (ripe with no brown spots, peeled and cubed)
16 ounces German wheat beer

**Hefeweizen Masa Dough Ingredients:**

4 cups masa harina
2 beets (red, medium sized, peeled and grated fine — optional)
2 tablespoons kosher salt
2 teaspoons baking powder
2 teaspoons coriander (ground)
½ teaspoon clove (ground)
1 lemon (zested, then juiced, removing seeds)
1 cup lard (rendered pork fat) or vegetable shortening
24 ounces German hefeweizen (at room temperature)

**Other Ingredients:**

1 each large banana leaf, cut into 6x10 inch rectangles (about 16 total) or corn husks

**Banana Chicken Curry Directions:**

Before starting the curry, it is easiest to have all the ingredients prepared and premeasured. In a large pot or Dutch oven, placed over medium high heat, add the ghee. Once melted, add the mustard seeds and coriander, swirling the pot, toasting the spices and allowing them to release their oils into the fat. When the spices start to pop (about 1 minute), add the onions and toss to coat evenly with the oil, then sauté the onions, stirring frequently, to brown them. After 8–10 minutes, drop the heat to medium and continue to cook the onions down for another 8–10 minutes. The onions should be an even dark brown color, but not burnt. As the onions are cooking, add the cubed chicken thighs to a bowl and season with the salt. Add the cashews, coconut and bananas to the bowl. Add the ginger, garam masala and chilies to the pot, stirring to blend together and let cook for another minute or two. Next add the chicken mixture to the pot and stir to combine and cook for 3 minutes. Add the beer, checking to ensure that the liquid just covers all the ingredients in the pot and bring to a simmer. Continue to cook on medium heat for 40–50 minutes, stirring frequently to prevent sticking and burning on the bottom of the pan. The meat will be fully cooked and tender, while the beer has reduced to make a sauce with the onions.

Cool the curry mixture down and chill

thoroughly. The banana chicken curry can be made up to 2 days in advance and used to fill the tamales later.

### Hefeweizen Masa Dough Directions:

In the bowl of a mixer fitted with a paddle attachment, add the dried masa, grated beet if using (more for color and presentation than flavor), salt, baking powder, coriander, clove and lemon zest. Turn the mixer onto a low speed and let the ingredients combine for about a minute. Add the lard or shortening and mix until the fat is incorporated and the masa forms small pea shape pebbles, about 2–3 minutes. Add the lemon juice and then add the hefeweizen in a slow stream into the mixing bowl. Once the liquid has been incorporated, increase the speed to high and beat for 3-4 minutes; the mixture should be light and fluffy. Turn off the mixer, remove the paddle attachment and cover with plastic wrap and let sit for 30 minutes, allowing the liquid to be fully absorbed into the masa.

### How to Assemble a Tamale:

First wash, dry and cut the banana leaves to size. Then, carefully drag the banana leaf through a flame on the stove, a BBQ or using a torch, lightly wilt the leave (about 3–5 seconds per side). This will make the banana leaf more pliable and prevent cracking during the rolling of the tamale.

Divide the masa dough into 16 equal size portions, about ½ cup each. Place the masa dough into the center of a banana leaf (or corn husk soaked in water for 30 minutes if banana leaves are unavailable). Using the palm of your hand as a press, squish the dough, making a 4 X 6 inch rectangle, about ¼ inch thick. This can be a job for one person, while another can help with filling the tamale (this will speed up the process).

To fill the tamale, place about 2–3 heaping tablespoons of cold banana chicken curry into the center of the pressed masa, forming an oval shape. Taking the leaf with a hand on each side of the wrapper, fold/roll like a taco, bringing each side together, keeping the filling inside and join the masa dough together. Then wrap one side of the leaf around the masa, rolling the tamale together, pressing the masa together to seal the dough and form a long cylinder. Fold the leaf over the tamale and wrap almost like a present or a burrito, starting lengthwise, and then folding the sides underneath. Repeat this process with remaining husks.

To cook: use a steamer and fill the bottom of a pot with 3–4 inches of water or more hefeweizen. Bring to a simmer over medium heat, covering the pot with a tight fitting lid. Steam the tamales for 40–45 minutes. Remove and let cool slightly before peeling and consuming.

## Hefeweizen Pudding

*A banana pudding, without the bananas.*

Serves: 4-6 guests

### Hefeweizen Pudding Ingredients:

1½ cups heavy cream
1½ cups hefeweizen
1 vanilla bean (split in half, seeds scraped out)
1 cup sugar (preferably organic)
⅓ cup corn starch
¼ teaspoon sea salt
¼ teaspoon clove (ground)
2 eggs (large, at room temperature)
4 egg yolks (large, at room temperate)
¼ cup dried Bavarian wheat malt extract
¼ cup sugar
4 tablespoons butter (unsalted)
1 teaspoon vanilla bourbon extract

### Directions:

In a medium size heavy bottom pot, over medium heat, add the cream, hefeweizen, vanilla bean and seeds, sugar, salt and clove. Mix together with a wooden spoon and bring to a boil, then turn off the heat and let the flavors infuse. In a medium size bowl, add the eggs, yolks, malt powder, remaining sugar and cornstarch; and whisk together until pale yellow, about 1 minute. Using a ladle, add some of the cream beer mixture to the egg mixture and whisk to combine, tempering the egg mixture, preventing the eggs from scrambling. Repeat this process a few times, bringing the temperature of the egg mixture close to the temperature of the cream beer mix, then transfer to the pot. Turn the heat to medium low and bring the mixture back to a simmer and cook for about two minutes.The mixture will thicken. Scrape the bottom of the pot with the wooden spoon.

Transfer the pudding to a mixer fitted with a whisk attachment and turn on to a medium speed. As the pudding beats, the slightly curdled eggs will break down, creating a slightly airy and silky custard. Add the butter and whisk for 15–20 minutes, cooling the mixture to room temperature. Add the vanilla extract and mix well.

Finally, transfer the pudding to a serving container or individual bowls, placing a sheet of plastic wrap over the surface to prevent a film from forming on the top of the finished pudding.

Place the finished pudding into the refrigerator and chill for at least two hours or until ready to serve. BYO

# the effects of **STORAGE CONDITIONS** on homebrew quality

Story by **Chris Colby & James Spencer**

Photos by James Spencer

# colLABorative

We all know that it is best to store beer cold. However, we also know that sometimes that's not possible. Sometimes there's no room in the fridge and a case or keg of homebrew may need to sit out at room temperature. And unfortunately, sometimes homebrew gets subjected to even worse environments. In this experiment, the fifth in our series of BYO/BBR Collaborative Brewing Experiments. we test how different conditions of beer storage affect bottled homebrew.

Of course, the effect of storage conditions on beer quality has been well tested on the commercial side with fizzy yellow lagers, but we're talking about homebrew. Homebrew may be bottle conditioned. Homebrew may be strong. Homebrew may be dark, or brewed with a funky yeast strain or any number of other things. Do these factors alter the aging process? To what extent? And how long can you store homebrew under different conditions? These are the questions we're asking. Here's the experiment we hope will provide (at least some of) the answers:

## The Test

This experiment was very straightforward. All participants needed to do was to take 12 bottles of homebrew, store them under different conditions and sample them at the appropriate times. Here's how we explained the experimental protocol, when we announced it on the byo.com blog:

"Take 12 bottles from one batch of homebrew, ideally all in the same type bottles, and treat them all equally until the experiment starts. If the beer needs to bottle condition, do this before the start of the experiment. Separate the 12 beers into 4 groups of three bottles. The four groups will be cold storage, cool storage, warm storage and variable storage. Place the three cold storage beers in your refrigerator. (Label them so you don't accidentally drink one before the proper time.) Place the three cool storage beers in a relative cool place (like a basement). Cover them so that they aren't exposed to light. (It's dark inside a refrigerator.) Take the temperature they are stored at. (If possible, measure temperature over the entire storage time with a high-low thermometer, so you know the range.) If you don't have an actual cool spot in your house, pick a spot that's room temperature. Take the three warm storage beers and place them somewhere warm, or even hot (like an attic or outdoor storage shed). Again, keep them dark and record the temperature.

"Finally, take the three variable storage beers and put them in the fridge. After a week, move them to warm storage and repeat so the variable storage beers cycle between


## OUTSIDE PARTICIPANTS

**Ernie Minetti**
West Berkshire, Vermont
Beer Type: Irish Red
Storage Conditions:
Fridge at 40 °F (4.4 °C)
Cellar at 50–60 °F (10–16 °C)
Tasting at: 8 months
Results: No differences detected between the samples

**Bill Schomer**
West Lafayette, Indiana
Beer Type: Wheat Beer
Storage Conditions:
Fridge at 40 °F (4.4 °C)
Basement at 70 °F (21 °C)
Garage 90–100 °F (32–38 °C)
Tastings at: 2 weeks and 5 months
Results: Garage-aged beer was darker at late tasting

**Zot O'Connor**
Seattle, Washington
Storage Conditions:
Fridge at 40 °F (4.4 °C)
Cellar at 60 °F (16 °C)
On Fridge Coils (up to 90 °F/32 °C)
Tastings at: 6 and 24 weeks
Results: Cellar-aged beer preferred at first tasting; mixed results at second

a week in the cold and a week of warm storage. (There will be one slight twist on this schedule for the first sampling.)

"To assess how the beers hold up under the various storage conditions, you will sample the beers after 1 week, 10 weeks and 25 weeks. The day before each sampling day, take one cool storage beer and one warm storage beer and move it to the fridge. Move the variable storage beer to the fridge, if needed. Let them cool overnight, then sample the beers the next night. Taste the beers side by side and note any differences. The biggest thing you will be looking for is differences in taste and aroma, but also look for things such as foam stand and clarity. If you can enlist someone to pour the beers for you, so you are tasting them blind, all the better."

In practice, the experiment was altered slightly by each participant, but the basic idea was preserved — store the beer under different conditions and sample at a couple different times.

## The Results

In general, the results fell in line with our expectations. As you might guess, storing beer in very warm conditions causes it to deteriorate quickly. Conversely, storing beer in the refrigerator keeps it fresh for an extended period of time. We did, however, obtain some interesting results for beers stored cool or at room temperature. These results may help guide homebrewers in decisions about how to store homebrew (especially in the short term) and even how to gauge how commercial beer may be effected if it is displayed warm at the store.

One of us (Spencer) took his bottles of beer — an IPA from a previous BYO/BBR experiment — and stored some in his fridge (at around 43 °F/ 6 °C), some in his basement (at around 70 °F/21 °C) and some in his attic (in which the temperature varied, peaking at 120 °F/49 °C). After 5 and 10 weeks, tastings were arranged.

The first tasting panel consisted of James Spencer along with Steve Wilkes, Andy Sparks and Alex Roberts. Steve, Andy and Alex were presented with the three beers and asked for their opinions. No details were given about what the experiment entailed (or even that these were experimental beers). The results from this tasting were clear and can be summarized concisely. The beer stored in the attic had serious off aromas, although it tasted better than it smelled. Steve Wilkes offered the guess that it was a beer that had been aged for a long time. The other two beers tasted very similar to each other.

The second tasting panel, which occurred 5 weeks after the first, consisted of James, Steve and Andy. Chris Colby joined the panel via Skype. (James shipped three of his beers to Chris.) In this tasting, the beers were numbered and everyone was aware of the nature of the experiment, but only James knew which beers were which. As you might expect, the beer stored in the attic was easily picked out of the lineup. Its hop aroma was greatly diminished compared to the other beers and had an unpleasant character to it. The beer also smelled like cardboard, a clear sign of oxidation. Its flavor was hard to describe other than tasting like very old beer. Steve Wilkes commented that it had some characteristics he had tasted in old ales (the beer style). Two of the panelists (Andy and Chris) noted that they had somewhat frequently encountered this suite of aromas and flavors — although not to the extent seen in the "attic beer" — in commercial beers, especially those imported from Europe. (Indeed it has been suggested many times that much of what US beer drinkers view as "imported beer taste" may simply be staling or oxidation.)

The beer aged in the refrigerator was judged to still be in good condition. It still had a fresh, hoppy aroma and tasted crisp and clean. By the time of the second tasting, however, the panel was able to distinguish the beer aged at room temperature from the fridge-aged sample. Its hop aroma was diminished slightly and was also judged to be slightly "off." The bitterness that was very pleasing in the fridge-aged sample came off as slightly harsh in the room temperature beer. In all, it seemed to be headed in the same direction as the attic-aged beer, but was far from showing the degree of off flavors and aroma that beer exhibited.

Finally, there was a variably-aged beer (not tasted by Chris) that was deemed to be in a similar condition to the room temperature aged beer.

As with all BYO/BBR Collaborative Experiments, BYO readers and BBR listeners also participated. Zot O'Connor stored a pale ale and held tastings with his homebrew club (Mount Si Brewing Society) at 6 and 24 weeks. He stored his beers in a fridge, a cellar (at 62 °F/17 °C) and on refrigerator coils (at 90 °F/32 °C). In the first test, held blindly, the tasters preferred the cellar-aged beer, which they judged to have a fuller Cascade flavor and aroma, compared to the cold aged beer. In the later (non-blind) tasting, results were split between preferring the cold-aged and cellar-aged beers. As expected, the warm-aged beers suffered from their handling. The variable beer was found to be similar to the cellar beer in the first tasting, but more similar to the warm-aged beer in the second.

Ernie Minetti stored his Irish red ale in a fridge and in a 200-year old cellar (at 50–60 °F/10–16 °C). After 8 months, he could not tell any difference between the aroma and flavor of the two differently stored samples.

Bill Schomer's wheat beer was stored in his fridge, basement (around 70 °F/21 °C) and garage (90–100 °F/32–38 °C) and tasted at 2 weeks and 5 months. In both tastings, Bill preferred the basement-aged beer, but differences in carbonation may have obscured the results.

Interestingly, his garage-aged beer ended up darker in the later sampling than the other beers. He was the only participant to detect color changes between treatments.

Our results mainly confirmed what we already knew about beer storage. However, the fact that some preferred beers stored at "cellar" temperatures, at least in the short term, is interesting. Also, it's good to know that a few weeks at "room temperature" doesn't harm beer noticeably. BYO

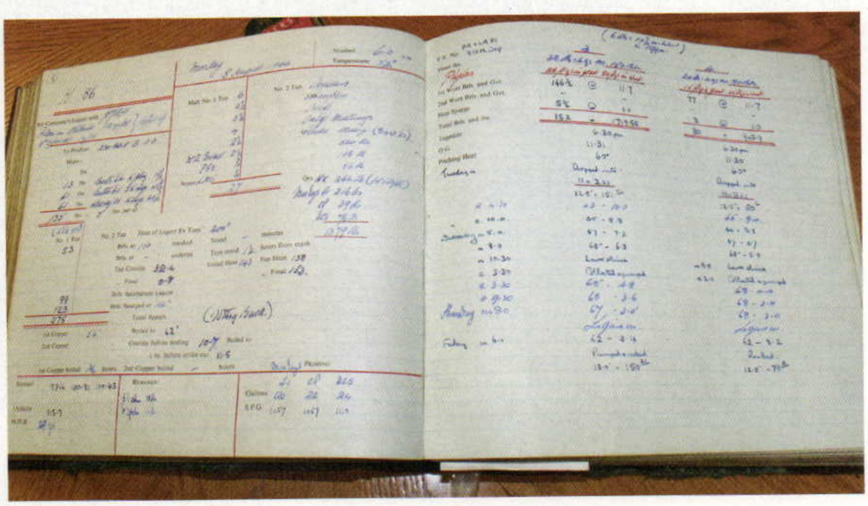
*Read Chris' blog (www.byo.com) or listen to James's podcast (www.basicbrewing.com) for the announcement of the next* BYO/BBR *experiment.*

Fuller's modern brewhouse sits on the same Chiswick, West London site where beer has been brewed for over 350 years.

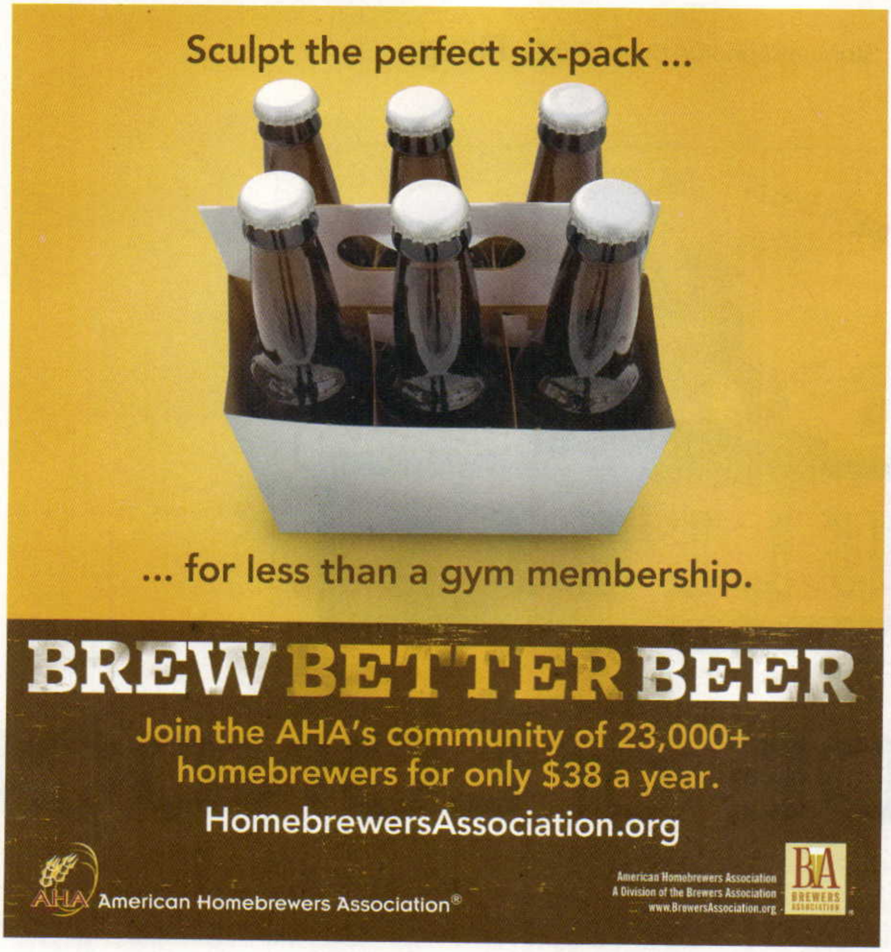
Story and photos by **Brad Ring**

# the **PRIDE** of **LONDON**

**FULLER'S BREWING DIRECTOR JOHN KEELING** walked over to a large bookcase in his office at the Griffin Brewery in Chiswick, West London and pulled out one of the dozens of leather-bound, thick, oversized journals from the shelves. "Since 1845, every single batch of beer brewed here has been entered by hand into these brew books by the Head Brewer," he said. "So I can look at what was used for ingredients in the late 19th Century or what my predecessor Reg Drury was doing before me. It gives me a great sense of history when I enter the latest batch in one of these journals, but I also enjoy thumbing through older brew books for ideas and rediscovering the past."



TOP: Fuller's Brewing Director John Keeling looks through one of the dozens of brewing journals dating back to 1845 with every Fuller's batch entered by hand.
RIGHT: The notes from a 1966 batch.





Keeling oversees the brewing of award-winning beers like London Pride and ESB for Fuller Smith & Turner P.L.C., known to most beer lovers as simply Fuller's. History seeps through Fuller's beyond the impressive collection of annual brewing journals in Keeling's office. Beer has been brewed on Fuller's Chiswick site for over 350 years and the brewery has been in the Fuller's extended family for the last 160 years. A brewery tour includes walking past a now retired 160-barrel brick-wrapped copper (boil kettle) dating back to 1823 as well as plenty other brewing artifacts from centuries past. And even though the current brewhouse is the picture of modernity with computer-controls and all stainless-steel equipment, Fuller's does carry on its historic march by continuing to use an old technique for producing some of its leading beers that is very rare in today's commercial breweries: parti-gyle brewing.

### Parti-Pride

To brew some of its leading brands, including ESB, London Pride, Golden Pride and Chiswick Bitter, Keeling harks back to tradition with his new stainless tools and uses the parti-gyle technique combined with blending to


Fuller's ESB is one of several beers brewed using the parti-gyle technique.

make up to four different beers from a single batch.

"It's the same grist for each of those beers," said Keeling. "Very simple. 95% British pale ale malt with 5% crystal malt (with a color of 75 °L). We mash it for 60 minutes between 64–65 °C (147–149 °F) and recirculate the runnings until clear. We begin sparging with 76 °C (169 °F) water and then start to collect the runnings. The first runnings all go into the first copper, which is completely filled as the sparging continues. This will be higher gravity. A second copper is filled with the rest of the runnings. Then each copper has a one-hour boil with the first copper using a much higher percentage of bittering hops than the second, lower-gravity, copper. We use Target as our bittering hops. Then we pitch yeast for both coppers at 17 °C (63 °F) before raising the temperature up to 20 °C (68 °F) for the main fermentation. Then it is lowered again."

Keeling and his crew blend back the two collections of runnings in various percentages to come up with their four different beers. Golden Pride, an 8.5% ABV barleywine, will have the highest percentage of the first, high-gravity, copper. On the other end of the scale, Chiswick Bitter weighing in at 3.5%

Continued on page 44


# Fuller's Clone Recipes

### Fuller's London Pride clone
**(5 gallons/19 L, all-grain)**
OG = 1.048 FG = 1.012
IBU = 33 SRM = 14
ABV = 4.7%


*This recipe is for the bottled version of London Pride. In the UK, London Pride is brewed to 4.1% ABV for cask and keg. In North America, the keg version available is the same strength as the bottled 4.7% ABV.*

**Ingredients**
- 9.0 lbs. (4.1 kg) Muntons pale ale malt
- 14 oz. (0.40 kg) crystal malt (75 °L)
- 5.83 AAU Target hops (60 min) (0.53 oz./15 g of 11% alpha acids)
- 2.63 AAU Challenger hops (15 min) (0.35 oz./9.9 g of 7.5% alpha acids)
- 2.98 AAU Northdown hops (15 min) (0.35 oz./9.9 g of 8.5% alpha acids)
- Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast

**Step by Step**
Mash at 149 °F (65 °C) for 60 minutes. Boil for 60 minutes adding Target for the full boil. With 15 minutes left in the boil, add Challenger and Northdown hops. Cool wort, transfer to fermenter and pitch yeast. Ferment at 68 °F (20 °C).

### Fuller's London Pride clone
**(5 gallons/19 L, extract with grains)**
OG = 1.048 FG = 1.012
IBU = 33 SRM = 14
ABV = 4.7%

**Ingredients**
- 6.6 lbs. (3.0 kg) Muntons Light liquid malt extract
- 14 oz. (0.40 kg) crystal malt (75 °L)
- 5.83 AAU Target hops (60 min) (0.53 oz./15 g of 11% alpha acids)
- 2.63 AAU Challenger hops (15 min) (0.35 oz./9.9 g of 7.5% alpha acids)
- 2.98 AAU Northdown hops (15 min) (0.35 oz./9.9 g of 8.5% alpha acids)
- 1 tsp Irish moss
- Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast

**Step by Step**
Steep crystal malt at 153 °F (67 °C) in 3 quarts (2.8 L) for 45 minutes. Add liquid malt extract and water to make 3.0 gallons (11 L). Boil for 60 minutes, adding hops at the times indicated. Cool wort and transfer to fermenter. Pitch yeast and ferment at 68 °F (20 °C).

### Fuller's ESB clone
**(5 gallons/ 19 L, all-grain)**
OG = 1.060 FG = 1.014
IBU = 35 SRM = 15
ABV = 5.9%


*This recipe is for the bottled version of ESB. The cask version in the UK is 5.5% ABV.*

**Ingredients**
- 11 lbs. 3 oz. (5.1 kg) Muntons pale ale malt
- 1 lb. 2 oz. (0.51 kg) crystal malt (75 °L)
- 5.25 AAU Target hops (60 min) (0.53 oz./15 g of 10% alpha acids)
- 2.6 AAU Challenger hops (60 min) (0.34 oz./10 g of 7.5% alpha acids)
- 0.83 AAU Northdown hops (15 min) (0.1 oz./2.7 g of 8.5% alpha acids)
- 1.66 AAU Goldings hops (15 min) (0.33 oz./9.4 g of 5% alpha acids)
- 0.33 oz. (9.4 g) Goldings hops (dry hop)
- Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast

**Step by Step**
Mash grains at 153 °F (67 °C) in 16.5 quarts (15.5 L) of water. Mash for 60 minutes. Collect 6.5 gallons (25 L) of wort. Boil for 60 minutes, adding hops at the times indicated. Cool and ferment at 69 °F (21 °C). Add Goldings dry hops to secondary fermenter.

### Fuller's ESB clone
**(5 gallons/ 19 L, extract with grains)**
OG = 1.060 FG = 1.014
IBU = 35 SRM = 15
ABV = 5.9%

**Ingredients**
- 1.3 lbs. (0.57 kg) Muntons Light dry malt extract
- 4.0 lbs. (1.8 kg) Muntons Light liquid malt extract (late addition)
- 3.3 lbs. (1.5 kg) Muntons pale ale malt

Label art courtesy of Fuller's

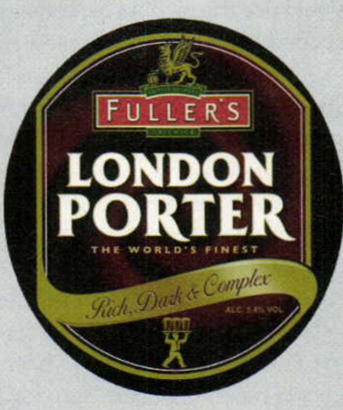
1 lb. 2 oz. (0.51 kg) crystal malt (75 °L)
5.25 AAU Target hops (60 min) (0.53 oz./15 g of 10% alpha acids)
2.6 AAU Challenger hops (60 min) (0.34 oz./10 g of 7.5% alpha acids)
0.83 AAU Northdown hops (15 min) (0.1 oz./2.7 g of 8.5% alpha acids)
1.66 AAU Goldings hops (15 min) (0.33 oz./9.4 g of 5% alpha acids)
0.33 oz. (9.4 g) Goldings hops (dry hop)
Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast

### Step by Step

Heat 3.4 quarts (3.2 L) of water to 165 °F (74 °C). Add crushed grains to grain bag. Submerge bag and let grains steep around 154 °F (68 °C) for 45 minutes. While grains steep, begin heating 2.25 gallons (8.5 L) of water in your brewpot. When steep is over, remove 1.1 qts. (~1.1 L) of water from brewpot and add to the grain tea in steeping pot. Place colander over brewpot and place steeping bag in it. Pour grain tea (with water added) through grain bag. Heat liquid in brewpot to a boil, then stir in dried malt extract, add the 60 minute hops and begin the boil. With 15 minutes left in boil, add the next addition of hops. Then turn off the heat and add the liquid malt extract. Stir well to dissolve, then resume heating. At the end of the boil, cool wort and transfer to fermenter, adding enough water to make 5.0 gallons (19 L). Pitch yeast and ferment at 70 °F (21 °C). Rack to secondary when fermentation is complete and add dry hops. Bottle a few days later when beer falls clear.

### Fuller's London Porter clone (5 gallons/ 19 L, all-grain)

OG = 1.054 FG = 1.014
IBU = 30 SRM = 46 ABV = 5.4%




### Ingredients

8.27 lbs. (3.75 kg) Muntons pale ale malt
1.0 lb. (0.45 kg) crystal malt (75 °L)
1.5 lbs. (0.68 kg) brown malt
0.75 lb. (0.34 kg) chocolate malt
6.25 AAU Fuggle hops (60 min) (1.3 oz./37 g of 4.7% alpha acids)
3.15 AAU Fuggle hops (15 min) (0.67 oz./19 g of 4.7% alpha acids)
Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast

### Step by Step

Mash at 153 °F (67 °C) for 60 minutes at mash thickness of 1.3 qt./lb. Boil for 60 minutes, adding hops at times indicated. Cool wort, transfer to fermenter and pitch yeast. Ferment at 62 °F (17 °C).

### Fuller's London Porter clone (5 gallons/ 19 L, partial mash)

OG = 1.054 FG = 1.014
IBU = 30 SRM = 46
ABV = 5.4%

### Ingredients

1.0 lb. (0.45 kg) Muntons pale ale malt
1.0 lb. (0.45 kg) crystal malt (75 °L)
1.5 lbs. (0.68 kg) brown malt
0.75 lb. (0.34 kg) chocolate malt
1.0 lb (0.45 kg) Muntons Light dried malt extract
4.0 lbs. (1.8 kg) Muntons Light liquid malt extract
6.25 AAU Fuggle hops (60 min) (1.3 oz./37 g of 4.7% alpha acids)
3.15 AAU Fuggle hops (15 min) (0.67 oz./19 g of 4.7% alpha acids)
Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast

### Step by Step

Partial mash grains at 153 °F (67 °C) for 45 minutes. Collect wort and add water to make 3.0 gallons (11 L). Stir in dried malt extract and bring to a boil. Boil 60 minutes, adding hops at times indicated. With 15 minutes left in boil, remove from heat and add liquid malt extract. Stir well to dissolve, then resume heating. At the end of the boil, cool wort and transfer to fermenter, adding enough water to make 5.0 gallons (19 L). Ferment at 62 °F (17 °C).


ABV, would use the highest percentage of the second copper containing lower-gravity runnings. Falling in the middle are ESB at 5.9% ABV and London Pride with an ABV of 4.7%.

While homebrewers can certainly experiment with parti-gyle techniques to produce multiple beers from a single batch, Keeling doesn't think it is a necessity to brew recreations of these Fuller's classics at home. "You can certainly get close to making these beers using a single recipe for each. You don't need to brew parti-gyle to get close," said Keeling. Keeling reviewed our clone recipes for London Pride, ESB and London Porter and you can find this collection of recipes on page 42.

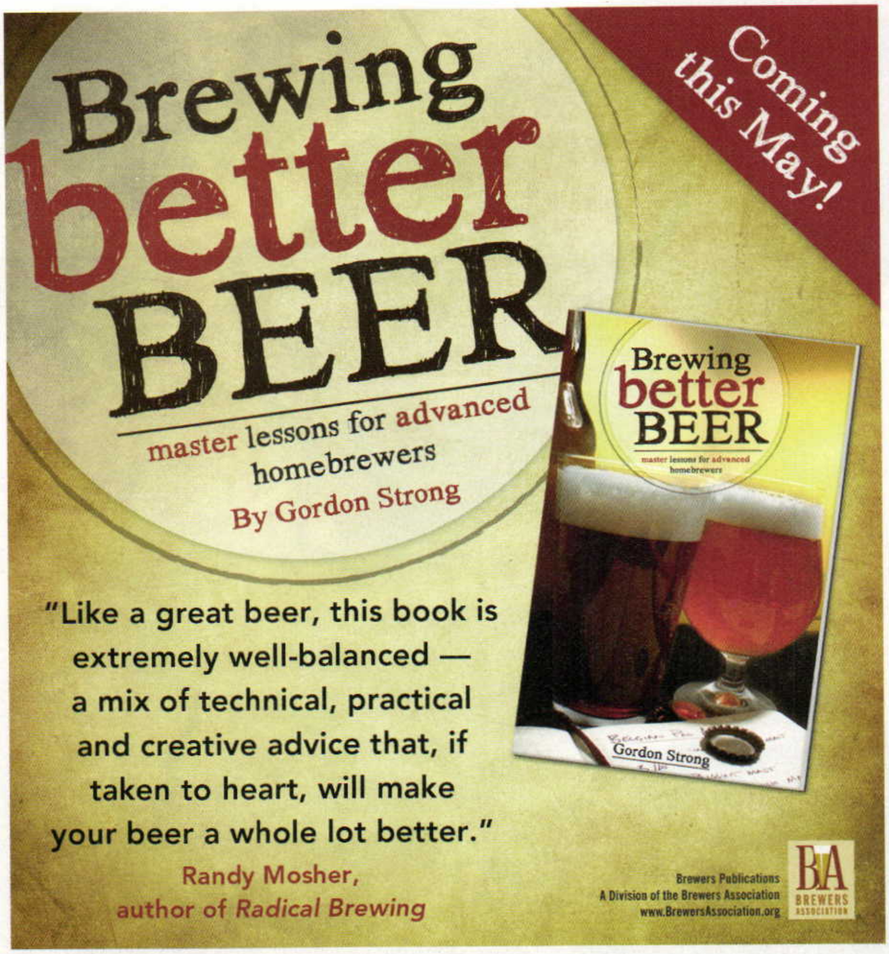
### Heritage

Parti-gyle or not, Keeling had one final piece of advice to share with homebrewers. Not surprisingly coming from a brewer surrounded by a rich history,

## When History Repeats Itself


Those heavy brewing journals in Keeling's office have inspired a new line of specialty beers for Fuller's called "Past Masters." The first selection just released is an XX Strong Ale based on a recipe from the September 2, 1891 log book that uses an old barley variety called Plumage Archer. Fuller's tracked down and grew the barley again just for this single batch of beer and had it drum malted (as was the standard in 1891) by Simpson's. The Plumage Archer is mixed with pale ale malt, crystal malt and invert sugar. The 7.5% ABV beer uses Fuggle and Goldings hops. You'll unfortunately need to visit Fuller's Brewery Shop in the UK to buy a 500 mL bottle of this limited release if you want a taste from 1891. Fuller's plan is to brew a new "Past Masters" beer using a different recipe from the Brew Book archives on an annual basis. "It is wonderful to have a chance to brew these recipes again and rediscover our brewing past," said Keeling.

Casks of London Pride awaiting delivery to pubs throughout the United Kingdom.




his main tip centered on looking forward by looking back. "As a brewer you need to understand heritage, meaning you need to first and foremost know your equipment. Brew the same recipe over and over again on your equipment. Make careful notes on each batch. Fancy leather brew books completely optional," he said laughing.

"Only when you understand your own history of brewing on your equipment can you honestly experiment. Have friends try your beer and accept criticism. Memory is a great thing except it doesn't always work so take detailed notes and learn from your mistakes. This is the best way to become a better brewer. And being a better brewer making better beer is certainly more fun."

Then Keeling closed the opened journal dated 1966, put it back on the shelf in its place, turned, smiled and said "heritage" one last time before going back to work. BYO

Brad Ring is the publisher of *Brew Your Own* magazine.

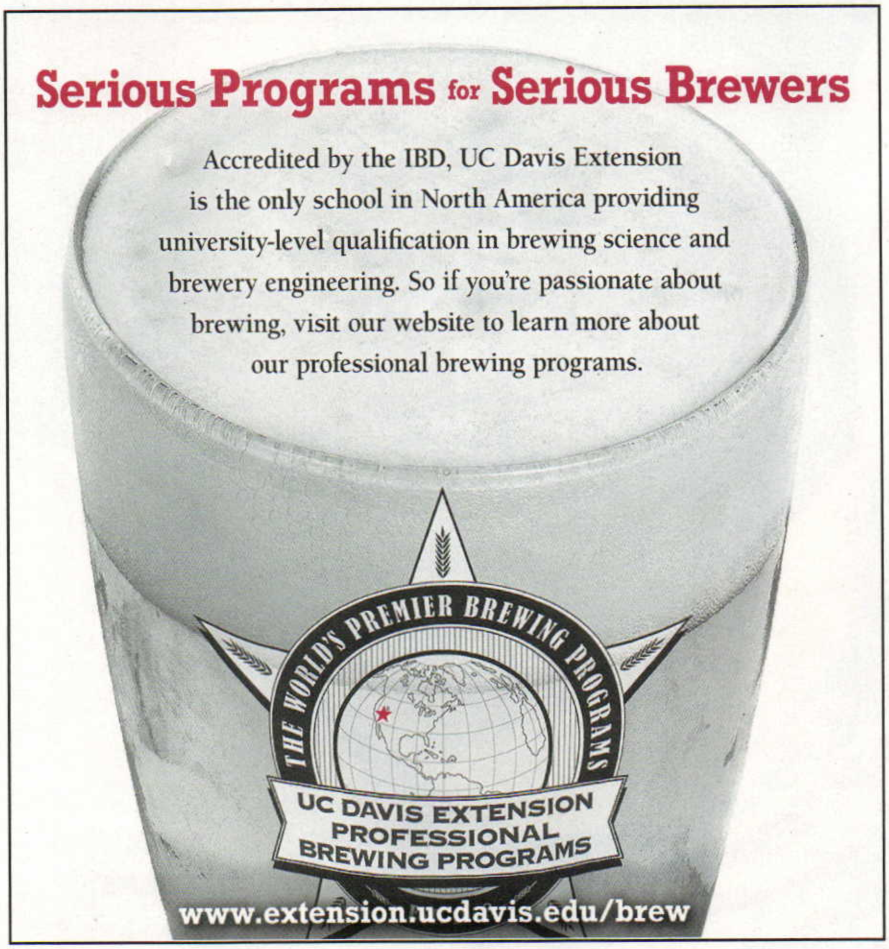


Photo by iStockPhoto

Story by **James Spencer**

# lagering techniques

Like most techniques in brewing, lagering was probably discovered by accident. Here's how the story goes: Hundreds of years ago, brewers in the region in and around Germany began storing, or "lagering" their beers during fermentation in caves over the winter. Over time, the yeast adapted to the colder conditions, not only surviving, but thriving and leading to a new branch of the brewers yeast family tree.

Unlike their cousins on the ale side of the family, who fell asleep and stopped working at lower temperatures, these cold-loving fungi kept going. The beer they produced took longer to condition, but was much "cleaner" than ales. Fewer by-products of fermentation meant less fruity beers that were more clear and crisp.

With the invention of refrigeration, brewers freed themselves from the climate-mandated schedule of seasonal brewing. In fact, in the late 1800s, breweries were the major users of refrigeration technology. Lagers could be produced any time of the year. Brewers took advantage of precise temperature control, and football fans would eventually rejoice.

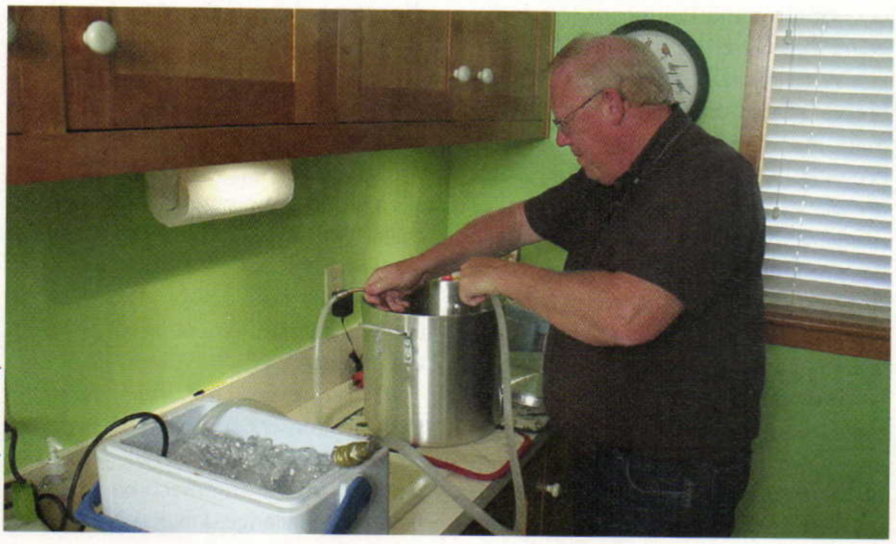
Nowadays, we homebrewers who want to brew classic lager styles, or invent our own, need to find solutions to the temperature issue. Ales can be brewed in the vicinity of "room temperature," especially if you employ the wet T-shirt trick. But how do we achieve and maintain the chilly temps required for lager fermentation? Lager yeast will ferment at higher ale temperatures, but the beer won't have the "clean" character of lager styles. There are a variety of methods homebrewers use to lager, and I'll summarize the major ones.

## Achieving Pitching Temperature

Brewers can pitch lager yeast at ale temperature and then chill the beer to lower lagering fermentation temperatures as the yeast starts to work. However, there is a chance the yeast cells will go dormant if they're chilled too fast. Many brewers choose to chill the wort to lager fermentation temperature before pitching.

So, our first challenge is to chill the wort down from boiling to lager temps in a reasonable amount of time. In the winter, colder tap water may give you a leg up on the process. An immersion chiller will easily knock down the initial load of heat. Counterflow and plate chillers will also do so, and — when used properly — use less water in the process.

After a few minutes, especially with an immersion chiller, the rate of temperature change will reach a plateau. In the summertime, this can be a real challenge. I live in Northwest



Photos by James Spencer

Arkansas, and our tap water temperature tops out at around 80 °F (27 °C). Even getting to ale fermentation temperature can be a problem.

An ice bath is a simple solution. When the chiller has done all it can to chill the wort, try immersing the kettle in a tub or sink of ice water. Stir frequently with a sanitized spoon to keep the wort circulating against the cold kettle walls. Also, frequently move the ice water around the outside and replenish ice as needed.

My favorite method of getting past the chiller's temperature plateau involves a pond pump. You can find these fairly cheaply at your local hardware store. Mine pumps at a maximum rate of 120 gallons per hour (450 L/hr).

When the temperature in the kettle levels out, I fill a small cooler with ice water and immerse the pond pump into it. I then connect the immersion chiller to the pump, putting the output of the chiller into the cooler of ice water. I found the fittings to connect the pump to the chiller at the hardware store. Now, when I plug the pump into the wall (using a ground fault protected socket), the pump circulates 32 °F (0 °C) water through the chiller and back into the cooler. I replenish the ice as it melts. This is effective in lowering the wort to lagering temperature, even in the heat of an Arkansas summer.

Another method employed by some homebrewers is to use their immersion chiller in the manner opposite of which it was intended. The

*Continued on page 50*

**TOP:**
Low-tech lagering solution developed by the author and Andy Sparks. (See article for details.)

**MIDDLE:**
An ice bath serves as a reservoir for cold water to be recirculated through a wort chiller after the boil.

**BOTTOM:**
A pond pump moves the water and Steve Wilkes swirls the wort chiller during wort chilling.

# lager recipes

## Parker's Pilsner
**(5 gallons/19 L, all-grain)**
OG = 1.052 FG = 1.013
IBU = 52 SRM = 4 ABV = 5.0%

*Inspired by traditional Bohemian Pilsners, but infused with a touch of American hops, this slightly "up-hopped" Bohemian Pils is light in color but big on hop flavor and aroma.*

### Ingredients
9 lb. 15 oz. (4.5 kg) Pilsner malt
10.6 oz. (300 g) CaraPils®
4 AAU Magnum hops (60 mins)
(0.25 oz./7.1 g of 16% alpha acids)
4 AAU Simcoe hops (60 mins)
(0.33 oz./9.4 g of 12% alpha acids)
5 AAU Centennial hops (15 mins)
(0.50 oz./14 g of 10% alpha acids)
3 AAU Saaz hops (15 mins)
(1.0 oz./28 g of 3% alpha acids)
0.35 oz. (10 g) Cascade hops (5 mins)
0.35 oz. (10 g) Amarillo hops (5 mins)
1.7 oz. (48 g) Saaz hops (5 mins)
1.4 oz. (40 g) Saaz whole hops
(dry hop)
¼ tsp $CaCl_2$ (75 mins)
Wyeast 2001 (Urquell Lager),
Wyeast 2278 (Czech Pils),
White Labs WLP800 (Pilsner Lager)
or White Labs WLP802
(Czech Budejovice Lager) yeast
(3.0 qt./~3 L yeast stater)

### Step by Step
If you adjust your water's chemistry, ensure that carbonates are below 50 ppm and calcium ions ($Ca^{2+}$) are in the 50–75 ppm range. [For 10 gallons of distilled water ($dH_2O$), add 2 tsp. calcium chloride ($CaCl_2$).] Make a yeast starter. Mash at 151 °F (66 °C) for 60 minutes. Recirculate wort before running off. Sparge with water hot enough to keep grain bed around 168 °F (76 °C). Collect about 6.5 gallons (25 L) of wort, or enough to yield 5.0 gallons (19 L) on your system after a 90-minute boil. Watch that the final runnings don't drop below 2 °Plato (SG 1.008). If they do, stop collecting wort and use water to reach pre-boil volume. Boil wort for 90 minutes. Add ¼ tsp $CaCl_2$ after 15 minutes. Add bittering hops with 1 hour left in boil. Add remaining hops at times indicated. Chill wort to 52 °F (11 °C). Chill yeast starter. Pour off liquid until about an inch (3 cm) above yeast sediment, swirl yeast and pitch. Aerate wort thoroughly. Ferment at 52 °F (11 °C). Add dry hops and let temperature rise for a diacetyl rest for 5 days at 60 °F (16 °C). Rack beer to new vessel (away from sediment and dry hops) and lager at ~40 °F (4.4 °C), refrigerator temperature, for at least six weeks.

## Parker's Pilsner
**(5 gallons/19 L, extract with grains)**
OG = 1.052 FG = 1.013
IBU = 52 SRM = 4 ABV = 5.0%

### Ingredients
4.75 lbs. (2.15 kg) light dried malt extract
(such as Briess CBW® Pilsen Light)
21.2 oz. (600 g) Pilsner malt
10.6 oz. (300 g) CaraPils®
4 AAU Magnum hops (60 mins)
(0.25 oz./7.1 g of 16% alpha acids)
4 AAU Simcoe hops (60 mins)
(0.33 oz./9.4 g of 12% alpha acids)
5 AAU Centennial hops (15 mins)
(0.50 oz./14 g of 10% alpha acids)
3 AAU Saaz hops (15 mins)
(1.0 oz./28 g of 3% alpha acids)
0.35 oz. (10 g) Cascade hops (5 mins)
0.35 oz. (10 g) Amarillo hops (5 mins)
1.7 oz. (48 g) Saaz hops (5 mins)
1.4 oz. (40 g) Saaz whole hops
(dry hop)
¼ tsp $CaCl_2$ (60 mins)
Wyeast 2001 (Urquell Lager),
Wyeast 2278 (Czech Pils),
White Labs WLP800 (Pilsner Lager)
or White Labs WLP802
(Czech Budejovice Lager) yeast
(3.0 qt./~3 L yeast stater)

### Step by Step
Use distilled water as your brewing water, except as directed. Make a yeast starter. Place crushed grains in a large steeping bag and steep in 3.0 qts. (2.8 L) of tap water at 151 °F (66 °C) for 45 minutes. Do this in a soup pot, not your brewpot. Remove bag and place in a strainer over brewpot. Pour "grain tea" through bag to filter out suspended particles. Rinse with 1.5 qts. (~1.5 L) of water at 168 °F (76 °C). Add water to brewpot to make at least 3.0 gallons (11 L) of wort, more if you can boil it vigorously. Stir in roughly half of the dried malt extract (or more — up to three quarters of it — if you do a full-wort boil). Boil wort for 65 minutes, adding ¼ tsp $CaCl_2$ and bittering hops with 1 hour left in boil. Add remaining hops at times indicated. Stir in remaining malt extract with 5 minutes left in the boil.

Chill wort and yeast starter. Rack to fermenter and make up volume to 5.0 gallons (19 L), if needed. Aerate wort thoroughly and pitch yeast. Ferment at 50 °F (10 °C). Add dry hops and let temperature rise for a diacetyl rest for 5 days at 60 °F (16 °C). Rack beer to new vessel (away from sediment and dry hops) and lager at 40 °F (4.4 °C), refrigerator temperature, for at least six weeks.

## Doc Ock's Octoberfest
**(5 gallons/19 L, all-grain)**
OG = 1.058 FG = 1.014
IBU = 24 SRM = 16 ABV = 5.6%

*An Octoberfest with a wonderfully malty aroma and flavor.*

### Ingredients
9 lb. 15 oz. (4.5 kg) Vienna malt
2 lb. 3 oz. (1.0 kg) Munich malt (10 °L)
5.3 oz. (0.15 kg) aromatic malt
5.3 oz. (0.15 kg) crystal malt (60 °L)
6.4 AAU Tettnang hops (60 min)
(1.6 oz./45 g at 4% alpha acids)
¼ tsp $CaCl_2$ (75 mins)
White Labs WLP820 (Octoberfest Lager), Wyeast 2206 (Bavarian Lager), White Labs WLP 920 (Old Bavarian Lager) or Wyeast 2247 (European Lager) yeast
(4 qt./4 L yeast starter)

### Step by Step
If you adjust your water chemistry, aim for ~150 ppm carbonates and ~100–150 ppm calcium ($Ca^{2+}$). Starting with 10 gallons of $dH_20$, you would need to add 2 tsp. $NaHCO_3$ (baking soda), 2 tsp. $CaSO_4$ (gypsum) and 2 tsp. $CaCl_2$ (calcium chloride). Stir half of the mineral additions into mash, the rest into your sparge water. Make a yeast starter. Mash at 154 °F (68 °C). Recirculate wort before starting the run off. Sparge with water hot enough to keep grain bed around 168 °F (76 °C). Collect about 6.5 gallons (25 L) of wort, or enough to yield 5.0 gallons (19 L) on your system after a 90-minute boil. Boil wort for 90 minutes. Add ¼ tsp $CaCl_2$ after 15 minutes. Add hops with 1 hour left in boil. Chill wort and rack to fermenter. Aerate and pitch yeast from chilled yeast starter. Ferment at 55 °F (13 °C). Diacetyl rest for 3 days at 60 °F (16 °C). Lager at 40 °F (4.4 °C), refrigerator temperature, for at least eight weeks. Sample beer and extend lagering time, if required. Octoberfests were traditionally brewed in March to be ready for the fall celebration.

chiller is placed in a bucket of ice water, and hot wort is run off from the kettle, through the inside of the chiller and into the fermenter. By slowing the flow of wort and gently swirling the chiller, this can be very effective.

### The Wort's Cold. Now What?

One of the most common solutions for fermenting lagers at home is to use refrigeration, as commercial brewers do. Chest freezers are perfect for this application, and come in a variety of sizes. A 14.8 cubic foot freezer, a common large size, can hold four 6.5-gallon (25-L) carboys or seven 5.0-gallon (19-L) Cornelius kegs. A chest freezer paired with an external temperature controller gives the size, power and flexibility needed to keep the yeast in their happy zone for producing lagers. An external thermostat is required because the thermostat supplied with a chest freezer only works in a narrow range, far below lagering temperatures. Johnson Controls and Ranco make controllers that are sold at many homebrew shops. The freezer is plugged into the controller. A sensor connected to the controller monitors the temperature in the freezer, and setting or changing the temperature in the freezer is as easy as turning a control dial or pushing buttons on the controller. When the temperature in the freezer rises above the set temperature, the controller switches the power on to the freezer. When the temperature drops to a few degrees below the set temperature, the power is cut off.

The flexibility of an electronic controller comes in handy for lagering. The first stage of primary lager fermentation happens at around 45–55 °F (7–13 °C). At or near the end of primary fermentation, many brewers choose to do a diacetyl rest, raising the temperature up closer to ale temperatures (often around 60 °F/15 °C) for a short time to help the yeast clean up buttery or butterscotch off-flavors. Then, it's a gradual lowering down closer to freezing for long-term lager aging.

Many brewers find cheap, or even free, used freezers online or in the classified ads for use as lagering chillers or kegerators. There is a drawback to using one freezer for both. The low temperature required for long-term lagering may be too low for the proper serving temperatures for some beers — especially ales.

Also, old used freezers may be extremely energy inefficient. You may save money in the long run by purchasing a new more efficient model rather than going the "free" route. When shopping for a freezer, measure the height of your carboys, kegs or especially conical fermenters (with the airlocks attached) and also measure the depth of the freezer. Most have more than enough height for carboys and kegs, but you may need to build a "collar" to lift the door up to accommodate some conicals.

Speaking of conical fermenters, freestanding fermenters with glycol chilling are also available. These take up much less space in your brewery, but require an initial investment beyond what a chest freezer and controller will run you.

What if you don't have the cash or space for a chest freezer? What are other techniques homebrewers use to lager their beers? To find out, I used Facebook to poll friends and followers of our Basic Brewing podcasts.

> "One of the most common solutions for fermenting lagers at home is to use refrigeration . . ."

### ALTERNATIVE METHOD ONE: GET A CAVE

The simplest way to brew lagers is to do what they did in the old days — brew with the seasons. If you live in a suitable location, let Mother Nature do the work of keeping your beer in the proper range.

"Winter provides perfect temps in my garage for lagering," says Jairo Nunes. "In the first month of winter, its temp inside is around 50, then drops to around 40 for the remaining two months. Again, just perfect!"

"I live in Maine ('nuff said)," says Kevin Bailey. "In the winter, I set my carboy in the corner of my basement. I've built a three-sided foam box to put around the beer and trap the cold air. It stays at about 40 °F (4.4 °C). Not perfect, but my last lager was awesome!"

For some, maintaining a steady temperature for the yeast is a challenge and requires some physical exercise as the temperatures fluctuate with the weather. For Pete Bloor, his fermenter logs frequent traveler miles. "The garage, then back inside the house, then back into the garage, then into the house (for a rest), then back into the garage into the garage fridge," he says. "A bit more work, but a lot cheaper."

Bryan Lambert lagers in a curtained cool fireplace in the winter. Dan Shreffler lagers in his basement, moving his beer from one part to the other after initial fermentation is complete. For Jason Roseman, it's the garage.

In some parts of the world, Mother Nature takes it too far with the cold. "If my shed is 20 °F (-6.7 °C) and I want to lager at 35 °F (1.7 °C), I just need to add heat," Matthew Vardjan says. "An electric brew belt, space heater or even a light bulb in an insulated box can do a very good job at maintaining temperatures. For many homebrewers, it is much easier and cheaper to add heat than take it away."

Of all the methods, this is the least expensive, but it is also the one that offers the least in terms of temperature control. If you use environmental temperature control, you would be wise to invest in a high-low (or min-max) thermometer so you can monitor the range of temperatures your beer is exposed to during fermentation. (These are cheap and available at most home improvement or hardware stores.) Keep in the mind the beer itself will change in temperature more slowly than the surrounding air temperature. Find a place where the beer is buffered as much as possible from daily highs and lows and keep an eye on your local weather forecast for possible cold snaps or heat waves.

### ALTERNATIVE METHOD TWO: GET A TUB

If the ambient air temperature is unstable or unpredictable, immersing the fermenter into a container of water will help buffer it against temperature swings. Brewers have also discovered that the water can be heated or cooled to maintain the beer in the temperature sweet spot.

"In northern Minnesota, when mosquito season ends, lagering season begins," according to Patrick Sundberg. "I've fermented in a large tub in the garage with a 200-watt aquarium heater. This can easily keep the water 20 °F (-6.7 °C) above ambient. A salvaged desktop fountain pump circulates the water to maintain a constant temp."

Eric Lancaster employs a large Rubbermaid storage container filled with water to regulate his lager fermentations. He monitors the temperature with a stick-on temperature strip. "Add either frozen bottles of water or (polycarbonate) bottles of hot water from the tea kettle, depending on what temperature is needed," Eric says. "Put a towel over the whole thing to prevent skunking and provide insulation. I have to check it about 4–5 times a day for the first few days of fermentation, but only twice a day from then on."

"Lagers die a violent death out here in Arizona," says Rick Trujillo. "I have had success with half-batching in an ale pail, then submerging the pail in a beverage cooler — basically an ice bath. I monitor the temperature twice daily and add ice when needed to regulate. Not the funnest process, but it works."

### ALTERNATIVE METHOD THREE: GET INVENTIVE

When I wanted to get into lagering, I had no place to put a chest freezer, but I wanted to have the convenience of being able to set a temperature on an electronic controller and let it do the work of keeping a steady temperature. My buddy Andy Sparks and I put our heads together and came up with a system that sounds cumbersome but works well.

The system we designed takes the idea of a fermentation tub one step further. I discovered that a 5.0-gallon (19-L) plastic bucket fermenter or a 5.0-gallon (19-L) glass carboy would each fit into a 10-gallon (38-L) cylindrical Rubbermaid water cooler.

Initially, I had thought surrounding a fermenter with ice water in the cooler would be the way to go, monitoring the temperature frequently and adding ice as needed, as the brewers mention earlier. However, Andy suggested adding a second cooler with ice water and using a pond pump to circulate the cold water through tubes connecting the two. An electronic temperature controller with its sensor in the cooler with the fermenter would fire up the pump as necessary. When I set up the system, there was a snag. I connected the two drain plugs of the coolers, thinking that the water would return by gravity into the ice water cooler as the pump fed cold water into the fermenter's cooler. This didn't work. The water level in the cylindrical fermenter's cooler rose too quickly and threatened to overflow.

The solution turned out to be twenty feet of copper tubing, which I wrapped around the fermenter in the cylindrical cooler. When triggered by the sensor under the fermenter in cooler number one, the electronic controller sends electricity to the pond pump in cooler number two. Icy water travels through vinyl tubing from the pump to the copper tubing surrounding the fermenter, which is immersed in water. After working through the coil of copper tubing, the cooling water returns via another vinyl tube to cooler number two.

When the water surrounding the fermenter reaches the target temperature, the electronic controller shuts off the pump, and the lager yeast cells stay at the correct temperature.

It's essentially the same principle as a glycol-jacketed fermenter. I use frozen one-gallon (~ 4L) plastic water jugs as the ice in cooler number two. Depending on the time of year and the temperature of the fermentation, I may have to change out the jugs up to twice a day. While that's a bit of work, I know I don't have to worry about keeping my fermenter at a rock-steady temperature. I monitor this with a probe thermometer.

The system is featured in our Basic Brewing: Low-Tech Lagering and Decoction Mashing DVD.

At the end of primary fermentation, I dial the temperature up for a diacetyl rest. I then rack to a secondary fermenter and use the controller to gradually lower the temperature until it reaches the level I use for extended lagering. Using this system, I can easily maintain 40–45 °F (4.5–7 °C), even during summer.

## Acclimating the Yeast

Another temperature-related concern in lager brewing is ensuring that you don't thermally shock your yeast. The optimal pitching rate for lagers is twice that of ales for beers of the same original gravity (OG). As such, you should be making a yeast starter to raise a healthy pitch. However, if you grow your yeast at room temperature — as most homebrewers do — you need to cool it down before adding it to your chilled lager wort. Optimally, your yeast should be within 10 °F (5 °C) of the wort temperature or they may be shocked when pitched.

The easiest way to acclimate your yeast is simply to refrigerate your yeast starter on brew day starting a few hours before you pitch the yeast. If you have a stick-on thermometer strip on the outside of your starter vessel, you can monitor its temperature. The one catch to this is that cooling your starter can result in liquid being pulled from the fermentation lock into your starter beer. To prevent this, remove the fermentation lock before refrigerating your starter. Place a paper towel over the vessel's opening and secure it with a rubber band. Place a cap of aluminum foil over this.

## Is It Worth the Effort?

Depending on where you are, brewing a lager may be an expensive or troublesome endeavor. Given the hurdles some of us jump, some may ask, "Why not just stick to ales?"

By the same token, we could also ask, "Why brew our own beer?" There is no shortage of affordable beer on the market, including world-class craft beer. I believe the journey is as enjoyable as the end. When I watch the airlock bubble on a beer I've brewed, I get a sense of pleasure a commercial six-pack can't replace. And while I don't brew as many lagers as ales, the additional challenges of brewing lagers only make the taste of those beers in the glass sweeter (or more bitter, as the case may be). BYO

*James Spencer's podcast,* Basic Brewing Radio, *can be found at www.basicbrewing.com.*

Story by **Chris Colby**

# SOUTHERN HOP GROWING

## the problems and the promise

Photos by Chris Colby

TOP: With too much sun and heat, hop leaves will brown, even if well watered. MIDDLE AND RIGHT: In hot summers (2009 pictured), plants may survive, but not thrive. BOTTOM: In milder summers (2008 pictured), hop plants can flourish in the southern US.

In the Northern Hemisphere, hops are grown commercially in a band surrounding the 45th parallel (roughly from the 35th to the 55th). Famous US hop growing regions include the Yakima Valley in Washington and the Willamette Valley in Oregon. US homebrewers, however, grow hops in almost every part of the country, including the deep south. I have lived in Texas for the past 10 years and have grown hops the majority of that time. Growing hops in a hot southern climate is a challenge, but is possible if you are willing to put in a little extra time and effort and accept a few unavoidable limitations.

## The Problems

Southern US hop growers face two main problems — keeping the plants alive in the extreme heat and producing quality hops. Dealing with the heat in an ordinary year is not that difficult, although extremely hot years — in which the temperature hovers near 110 °F (43 °C) for a week or more — can end in catastrophe. Likewise, although producing hop cones is no problem, producing hop cones you would want to brew with is more of a challenge. Hops grown in warmer than optimal climates tend to have a grassy aroma. (For a general primer on hop growing, see *Brew Your Own*'s Hop Lover's Guide special issue.)

## Variety

In general, high-alpha hops are more heat tolerant than aroma hops. I have had good luck growing Centennial, Chinook, Zeus (Columbus/Tomahawk) and Northern Brewer in Texas. I have had mixed results growing Nugget. Perhaps the best choice, if you are only going to plant one vine, is Cascade — this variety is very hardy.

## Location

The biggest "trick" to growing hops in the southern US is to pick a location where they get sun in the morning and early afternoon, but shade throughout the hottest part of the day. When deciding where to plant, go outside in the morning and see which side of your house is getting sun. Later, in the hottest part of the day, see which parts of that region are in the shade. That is where you should plant your hops.

## Watering

Planted in the correct location, the next obvious need is to water the plants adequately. Hops grow vines (technically called bines) that can easily grow up to 30 feet (9.1 m) under good conditions. Each plant has a lot of leaf area exposed to the environment and they require a lot of water each day to replace that that is lost.

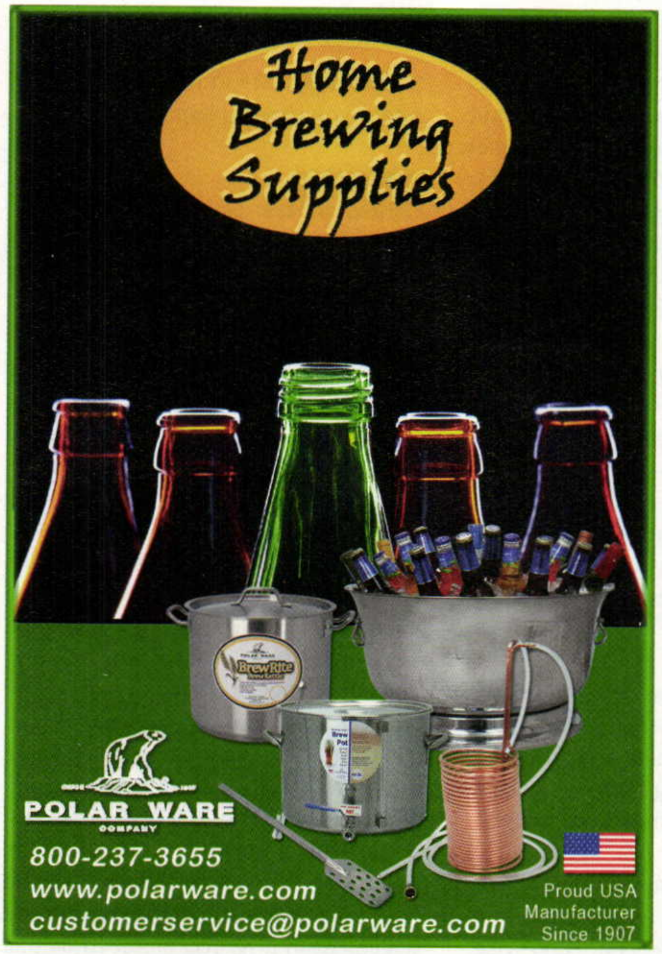
In order to give the plants the water they need, your watering should be aimed at soaking all the soil surrounding the roots. Underground, hop rhizomes grow into a large "crown." Their thin, white, fibrous roots extend from the crown at least a few feet in all directions. When watering your hops, don't just pour a bit of water right at the bottom of the stem — soak a circle of soil surrounding the vine by several feet. Keep watering until drainage slows and then repeat this process the next time you water. You need a deep soaking each time you water to wet all the roots. When the top centimeter or so of soil dries out, soak the plants.

## The Timing of Maturity

In the deep south, hops can begin sprouting in January and can yield cones as early as late June. In contrast, hops sprout much later in commercial growing latitudes and are harvested in late August through early September. In order for commercial hops to mature at the correct time, they are cut back at a certain time every year, usually a few weeks after sprouting. Some preliminary experiments, done by me, suggest that cutting hops back in late May will force the cones to come to maturity in mid-September or later, when conditions are cooler. In the few trials that survived, this diminished the grassy character somewhat, but more work — including brewing trials — needs to be done.

Southern hop growers face a variety of problems. But growing also holds some promise if the issue of quality can be addressed. BYO

*Chris Colby is the Editor of* Brew Your Own.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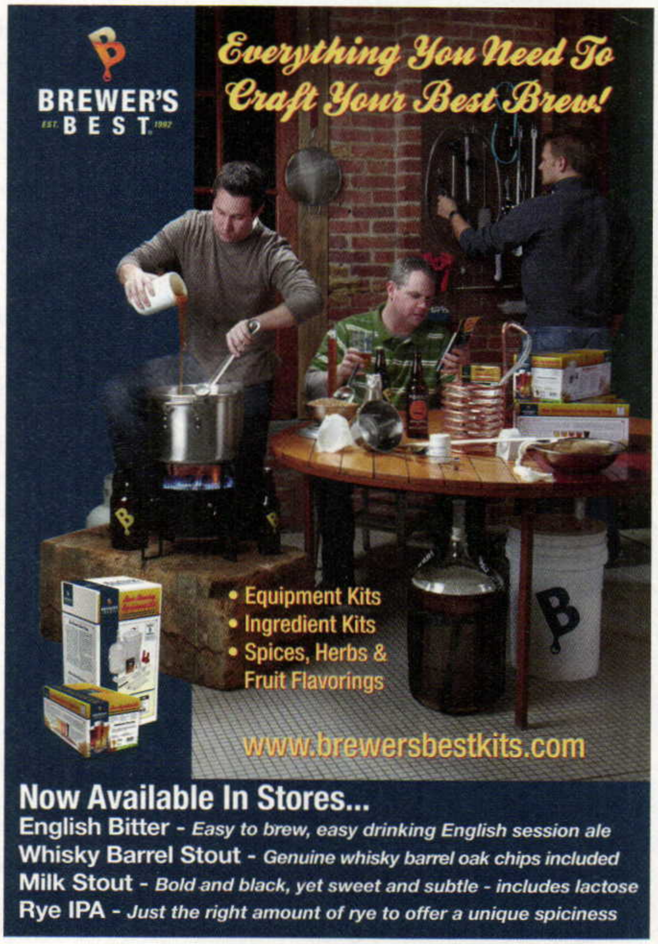
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# One Hop Wonder

## (Single hop brewing)

by Terry Foster

hops are the most important ingredient in beer. Well, perhaps that's debatable, but they certainly deliver some very important flavor components to beer. Many beers would be simply bland and sweet without hop bitterness, flavor and aroma. Yet using them properly, so as to produce a well-balanced beer, is no simple matter. It is very easy, especially with delicately-flavored beers, to actually spoil them (in flavor terms) by using the wrong hop. In short, if you want to be a good brewer and to be able to formulate your own recipes you need to know and understand what a particular hop variety can and cannot do. In fact, you really should know this even at the simpler level of brewing by following a recipe since taste is a very subjective thing. After all, what do you do when the varieties you happen to have in your refrigerator are other than those called for by the recipe? The answer is obvious — you need to learn about what you can expect from individual hop varieties.

### Hop experiments

Learning about individual hops should be straightforward enough, since all you need to do is to be a little scientific and plan out your experiments. Start with a base beer as a control, then repeat the brewing process several times, each time with a different hop variety. When you've completed all the individual brews, taste the results and make your comparisons.

You won't be surprised to hear that matters are not that simple. Without making a detailed search, but just by picking up a couple of recent homebrew supply catalogues, I find that there are at least 35 different hop varieties available to the home brewer. Craft brewers may have access to even more varieties, and of course new varieties regularly come onto the market.

On top of that, an individual flavor component may be modified or even masked by that of other components present in the beer. For example, the subtle spicy character of Hallertau hops may be swamped by the roasty notes of a dry stout.

Even making the somewhat dubious assumption that bittering hops make no other flavor contributions, and ignoring the debatable effects of first wort and mash hopping, you would have to look at two different additions for hop flavor and aroma, let's say one at the last 20 minutes of the boil, and one as the heat is turned off. And to do the thing properly you must vary these separately, each at several different addition levels. You probably also will want to look at the effect of dry hopping in the fermenter or cask as well, which means another addition needing to be separately monitored. What this comes down to is that you would need a statistically-designed experimental program, and even then you will probably be carrying out hundreds — possibly even thousands — of experiments. You don't have to be the winner of the Nobel Prize for mathematics to realize that such an approach is going to consume an enormous amount of your time and money.

### Analyze

You almost certainly do not want to mount such an undertaking, so how can we circumvent such labor? Well, there is another science-based approach, and that is to look at analyses of the chemical constituents of individual hop varieties. Thanks to modern analytical techniques there is a wealth of data out there, which your homebrew supplier may be able to provide. Failing that, go to hop merchant websites, such as Yakimachief.com, Hopunion.com or Hopsteiner.com. BYO.com also has an online hop chart in the resource guide section. Interpretation of such data is not easy, though many brewers see the foundation of this in results for the so-called

> "Learning about individual hops should be straightforward enough, since all you need to do is to be a little scientific and plan out your experiments."

Photo by Charles A. Parker

> "Take a couple of hop cones or pellets on the palm of one hand and rub gently until they are broken. The warmth of your hand will volatilize the oils and release their aromas . . ."

noble hops, Hallertauer Mittelfrüh, Tettnanger, Spalt and Czech Saaz. These are defined by an alpha-to-beta-acid ratio of about 1:1, around 20-25% of total alpha acids as cohumulone, myrcene in the oil below 50%, and humulene of 40% or more, and a ratio of humulene to caryophyllene greater than three.

There are a number of problems with this approach, the first being that you might find it confusing if you have little or no chemistry background. The second is that a lot of varieties are considered to be good brewing hops, yet do not fit the above definition of noble hops. Indeed, beyond this quite broad definition there is no clear and simple distinction between varieties and their brewing properties. And finally, this method may fall down on the fact that the precise chemical content of alpha and beta acids and oils will vary from year to year — hops are a natural product after all!

### Use your nose

So what other tools do we have for this purpose? Well the most accessible one and a quite sensitive one at that is your nose. Take a couple of hop cones or pellets on the palm of one hand and rub gently until they are broken. The warmth of your hand will volatilize the oils and release their aroma to your waiting nostrils. You can do this with several samples at one time and get an idea of what smells good to you, and is therefore likely to smell good in your beer. It is good practice to do this every time you brew, and to make notes of the results. This method is most often used to determine the freshness of a hop sample, but used as described above can give you some valuable insight into the behavior of different varieties.

It doesn't, of course, tell you anything about bittering properties, but your supplier will have provided you with the alpha acid content of the hops you bought. Further, most good suppliers will offer descriptions of the varieties they sell, along with recommendations for which beers they are best suited. Read these carefully, for they are a good source of information, and your reading can be backed up by discussing with the supplier what he recommends for the particular beer you have in mind. A further, complementary approach is to find out what hops are used in the craft beers that you like. Even better, if you can, is to talk to craft brewers, and try to find out not only what hops they use, but why they use them. Don't be afraid to ask them — in my experience craft brewers are only too happy to talk about their beers, often at great length!

### Single hop brewing

After you have done all that and selected your favorite varieties, you may want to refine your knowledge still further, or even to investigate new varieties as they become available. A good way to do this is to brew a beer with only one type of hop. That might sound like a bit of an academic exercise, but remember that concentration on single varietal wines was what turned the Californian wine industry around in the 1970s and 1980s. It can also help you in finding out where you can best use the hops — in other words whether it would be better to late hop or dry hop in your system. It will help you find out where to draw the line on bittering, and for example will permit you to determine whether a new high-alpha hop might give a harsh, rather than a clean bitterness. And by sticking to only one hop, any contribution to flavor from the bittering hops will not interfere with those from later additions.

"I think that you need to brew a beer style that is meant to have noticeable bitterness, hop character and aroma, but yet which has definite contributions from the malt."

What style of beer would be best for this purpose? Well, obviously one with strong flavors wouldn't work well as these might mask the hop flavors somewhat. It might seem obvious that you should start with a base beer that is very bland and neutral so that you can concentrate on the hop's contributions. But I do not consider that the best way to go, for I think that you need to brew a beer style that is meant to have noticeable bitterness, hop character and aroma, but yet which has definite contributions from the malt. That's because you want to brew a "real world" beer where bitterness and flavor accents from the hops will be modified by flavors derived from fermentation and the malt. And also it means that the end product will be enjoyable to

### Lonely Amarillo Pale Ale
**(5 gallons/19 L, extract)**
OG = 1.055 FG =1.013
IBU = 30 SRM = ±10 ABV = 5.5%

**Ingredients**
6 lb. (2.7 kg) pale liquid malt extract
1.5 lb. (0.68 kg) light dried malt extract
8.5 AAU Amarillo hop pellets (1 oz./28 g at 8.5% alpha acids) (60 min.)
1 oz. (28 g) Amarillo hop pellets (0 min.)
White Labs 001 (California Ale) or Wyeast 1056 (American Ale) yeast

**Step by Step**
Carefully dissolve the extracts in 3 gallons (11 L) of hot water, add water to bring the volume to 5 gallons (19 L). Bring to a boil and add the bittering hops. Boil 60 minutes, turn off heat, adjust volume back to 5 gallons (19 L) and make the second addition of hops. Let stand 15-30 minutes, cool to 65–70 °F (18-21°C), and pitch the yeast. When initial ferment has subsided rack to secondary, and leave for 1–2 weeks, before bottling or kegging in the usual manner.

**All-grain version**
Substitute 11 lb. (5 kg) 2-row pale malt plus 0.5 lb (0.23 kg) 40 °L caramel/crystal malt for the extracts in the above recipe. Mash at 150–152 °F (66–67 °C) for 90 minutes, run-off and sparge to collect 5.5–6.0 gallons (21–23 L) wort. Boil for 90 minutes adding bittering hops at start and flavor/aroma hops at finish. Let stand 15–20 minutes, pitch yeast then proceed as for the extract beer.

drink, and not just an experiment to be evaluated and then discarded. And in case it isn't obvious you can do this with either extract or all-grain brewing.

There are several candidates for this purpose, such as a good Pilsner, which is ideally suited for evaluating the more subtle "noble" hops mentioned earlier, as well as US derivatives of these, such as Liberty and Mt. Hood. Then there are various ales, with perhaps the best choice being a bitter or pale ale. I would opt for an American pale ale, preferably brewed with a clean yeast strain, such as an American Ale yeast like Wyeast 1056 (American Ale) or White Labs WLP001 (California Ale), since you don't want any esters getting in the way of the hop nuances. You don't want to start with too high a bitterness level, particularly if you want to investigate a low alpha-acid hop, such as Saaz, because you want to keep the hop bulk down. I'd shoot for 25–30 IBU and a single hop addition at the end of the boil (you can get more complicated later). So to the left, you will see an example using Amarillo hop pellets, the latter form being preferable since it gives more consistent results than whole hops, especially on a small scale.

### Further steps
After brewing your test batches of Amarillo pale ale from this recipe, you should take careful tasting notes on these beers when they are ready (it is a good idea to put a couple of bottles aside for later comparisons). You can then brew another version with the flavor hops added 15–20 minutes before the end of the boil, and see what difference this makes to the beer's flavor and aroma. You should then be able to decide which of the two additions pleases you most, or whether you want to make both additions (with of course an extra 1 oz/ 28 g of Amarillo). Next, make another version with your preferred late hopping schedule, and dry-hop with a further 1 oz. (28 g) of Amarillo pellets, added via a sanitized, weighted hop bag in the secondary fermenter. If you

> "You don't want to start with too high a bitterness level, particularly if you want to investigate a low alpha acid hop, such as Saaz, because you want to keep the hop bulk down."

have kept a couple of bottles back from each brew, you can do a direct comparison of the three beers, which with careful notes (again!) should give you a good idea as to how the different additions affect the beer's flavor and aroma. It will also help you decide what additions might have been made in a favorite craft beer which you want to clone.

There are many ways to go after that. Obviously you can try other hops, using your optimum additions developed as above in the same or different beers. For the latter, I would suggest you might consider making a pale Pilsner-type lager (at an OG of 1.048–1.050), with various additions of an aroma hop, such as Mt. Hood, or Styrian Goldings. Do that and you will soon have a very good idea of how and when to use your hops, and will become a hop expert. Just remember to never stop learning! BYO

*Terry Foster writes "Techniques" in every issue* of Brew Your Own .

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# Fermentation Kinetics

## Different ways to describe fermentation

by Chris Bible

Fermentation is a process in which biological molecules are broken down to provide energy for the fermenting organism. In alcoholic fermentation, sugars are broken down into ethyl alcohol and carbon dioxide. In the process, some of the energy from the sugars is transferred to other molecules (including ADP/ATP) that the cell uses as "energy currency." Some energy from the sugars is released as heat.

Fermentation involves complex interactions of biological, chemical and physical factors. Factors such as wort temperature, wort pH, yeast nutrient availability to the yeast cell, dissolved oxygen content, etc. all impact fermentation rate and the extent of fermentation of sugars by yeast.

### Attenuation

The extent of fermentation is easily determined by measuring the percentage of the available sugars that have been metabolized by the yeast at the conclusion of fermentation. The extent of fermentation of sugars by yeast is most often described as the degree of attenuation. Measuring the original gravity of the beer with a hydrometer, subtracting the final gravity and dividing this difference by the original gravity yields the apparent attenuation. Typical apparent attenuation ranges are 65–80%. This is called apparent attenuation because alcohol is less dense than water and thus lowers the final gravity reading of the finished beer, compared to if the solution only contained the residual carbohydrates and water. If the actual carbohydrate content of the beer can be determined, then the real attenuation can be calculated. This number is always less than the apparent attenuation. Knowledge of attenuation is useful to the brewer because it estimates the amount of residual sugars that will remain in the fermented beer. A larger amount of residual sugars are desired in some beer styles (e.g. doppelbocks) while fewer residual sugars are desired in other styles (e.g. American lagers).

### Kinetics

There are other ways to describe the progress of fermentation. Although these are more theoretically interesting than practically useful, they do give advanced homebrewers a greater appreciation of what is going on in our wort. The yeast's degree of attenuation can be thought of as an analog to a statement of chemical thermodynamic equilibrium: it tells you "how far you can go" with respect to the biochemical reaction of yeast converting fermentable sugars into ethanol and carbon dioxide.

Attenuation does not, however, address the rate at which the yeast cells convert fermentable sugars into ethanol and carbon dioxide. To describe the rate kinetics associated with our favorite biochemical reaction, it is necessary to understand some of the details that are involved with yeast metabolic activity.

When yeast food (mostly sugar) is plentiful within the wort, individual yeast cells carry out their metabolic activity with virtually no interference from the activity of neighboring cells. Each cell takes in nutrients and reproduces itself at a rate that is, for most practical considerations, independent of what any other nearby yeast cell may be doing. The individual yeast cell's metabolic activity is "unsynchronized" with any of its neighbors.

Since the total number of individual yeast cells within a fermentation vessel is very large, is makes sense to not consider the functioning of each single cell, but rather the overall functioning of the entire collection of yeast cells within a fermentation vessel.

By making the assumption that metabolic properties of a large number of individual cells can be thought of as individual, continuous functions, and that the specific activity of each individual cell can be combined together

"The extent of fermentation is easily determined by measuring the percentage of the available sugars that have been metabolized by the yeast . . ."

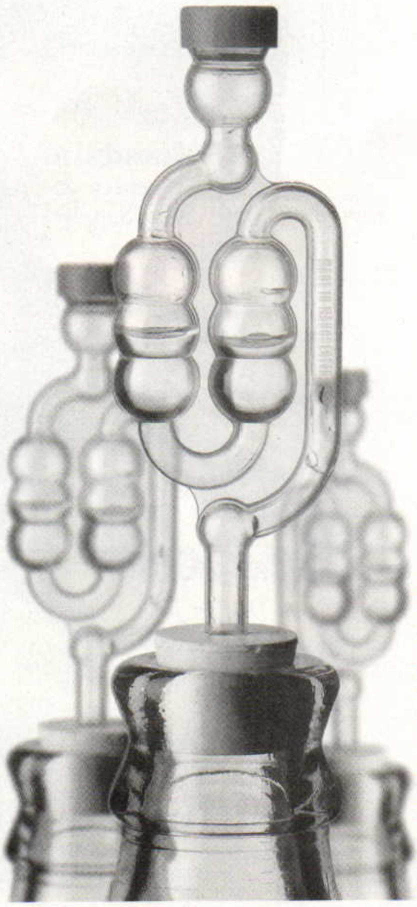


Photo by Charles A. Parker/Images Plus

so that the properties of the group of cells are taken in aggregate, we can then treat the overall fermentation kinetics of the group of cells as a continuous function (mathematically speaking).

To model the kinetics of fermentation, a mass balance of the system is required. The mass balance for an "unsynchronized" batch fermentation is given by equation 1:

$$\frac{dX}{dt} = \mu X - K_d X$$

and equation 2:

$$\frac{dS}{dt} = -\frac{\mu X}{Y}$$

with

μ = a function of S = f(S)

Where:
dX/dt = rate of change of yeast concentration (kg/m$^3$)/s
μ = specific yeast growth rate coefficient (s-1)
X = yeast concentration (kg/m$^3$)
$K_d$ = yeast death-rate coefficient (s-1), usually ≈ 0 for homebrewing situations
dS/dt = rate of change of substrate concentration (kg/m$^3$)/s
S = substrate ("yeast food") concentration (kg/m$^3$)
Y = yield coefficient (kg dry yeast produced/kg "food" used

A substrate is defined as a reactant that is taking place in the biochemical reaction (e.g dissolved, fermentable sugars). There are numerous functional relationships between μ and S that have been proposed, but one of the most universally accepted relationships for fermentation kinetics is given by the Monod equation (equation 3):

$$\mu = \frac{\mu_{max} S}{K_S + S}$$

Where:
μ = specific yeast growth rate coefficient (s-1)
$\mu_{max}$ = maximum specific yeast growth rate coefficient (s-1)
S = concentration of rate-limiting substrate (kg/m$^3$)
$K_s$ = Monod coefficient (kg/m$^3$)

These equations can be combined to give equation 4:

$$\frac{dX}{dt} = \mu X = \frac{\mu_{max} SX}{K_S + S}$$

and equation 5:

$$-\frac{dS}{dt}=\frac{\mu_{max}SX}{(K_S+S)Y}$$

The amount of yeast generated during the fermentation process can be described as equation 6:

$$X_t = X_0 + Y(S_0 - S_t)$$

Where:

$X_t$ = amount of yeast present at time t

$X_0$ = amount of yeast present at time t = 0

Y = yield coefficient (kg dry yeast produced/kg "food" used to make yeast)

$S_0$ = substrate ("yeast food") concentration (kg/m3) at time t=0

$S_t$ = substrate ("yeast food") concentration (kg/m3) at time t

Equations 5 and 6 can be combined to eliminate $X_t$ and can be integrated to obtain the integrated Monod equation for a growth substrate, equation 7:

$$t=\frac{1}{\mu_{max}}\left\{\left(\frac{K_S}{X_0+YS_0}+\frac{1}{Y}\right)\ln[X_0+Y(S_0-S_t)]+\left(\frac{K_S}{X_0+YS_0}\right)\ln\left(\frac{S_0}{X_0S_t}\right)-\frac{1}{Y}\ln(X_0)\right\}$$

This describes the amount of time required to reduce the concentration of fermentable sugars (the substrate) initially in the wort at time t = 0 from $S_0$ (initial sugar concentration) to $S_t$ (sugar concentration at time t) given the specific initial conditions and coefficients associated with the fermentation system.

### Fermentation phases

Measurements of specific gravity can tell us about the extent of fermentation and mathematics can describe the rate at which it occurs. A verbal description of the stages of fermentation can also help us learn more. Yeast cells fermenting wort progress through a series of stages as they carry out their work. These are the lag phase, the log phase, the post-log phase, stationary phase and the "death" phase. There is no hard boundary between each stage, they simply blur into each other.

The lag phase can be thought of as an "assimilation" phase for the yeast cells; they are becoming acclimated to the wort and are absorbing nutrients and compounds in preparation for reproduction. Little actual cell division is taking place. The log or exponential phase is a period of unrestrained reproduction. Yeast cell division is occurring at the maximum rate possible within the wort and the number of cells is increasing at an exponential rate. The reproduction rate is limited only by the yeast cell's own metabolic rate. Yeast biomass concentration during the log phase is given by equation 8:

$$X = X_0 e^{\mu(t_i - t_0)}$$

The post-log phase is characterized by a diminished rate of reproduction by the yeast cells. During this phase, the concentration of fermentable sugars has been lowered by the yeast activity during the log phase. The rate of yeast cell reproduction is becoming limited by the decreased concentration of fermentable sugars and by competition with other yeast cells. The assumption that there is an apparently "infinite supply" of food for the yeast is no longer valid. Yeast cells are beginning to compete with their immediate neighbors for resources.

The stationary phase is characterized by the cessation of reproduction of the yeast cells. There is no longer a sufficient concentration of fermentable sugars available for the production of new yeast cells. The existing yeast cells do continue to metabolize sugars during this phase, but they do not reproduce.

The death phase could also be described as the "dormant phase." Yeast growth stops and metabolic activity slows to a halt. Yeast flocculates and settles to the bottom of the fermentation vessel.

## Conclusion

To fully understand the fermentation process, the brewer must gain knowledge from a wide variety of sources. Combining what we know from all the disparate sources of information lets us best manage our fermentations. So, to end with some practical advice, here are some tips to ensure a healthy fermentation. (Most of these do not come from the mathematics presented here, which mainly describe the rate at which fermentation occurs.)

## To ensure success:

1. Select a yeast strain that is appropriate for the desired beer style
2. Use fresh, healthy yeast
3. Pitch as large a quantity of yeast as is practical
4. Adequately aerate wort prior to pitching yeast
5. Ensure that wort contains adequate yeast nutrients
6. Ferment beer within a temperature range appropriate for the yeast strain BYO

*Chris Bible is* BYO's *"Advanced Brewing" columnist.*

# Chest Freezer to Kegerator

## Tap your homebrew with style

by Bjorn Jansson

When I returned to homebrewing in 2008 after a several year-long hiatus, I quickly tired of bottling beer on the kitchen floor. What was once no big deal had became a pain in my backside, literally, and I quickly began looking for kegging solutions. Finding several successful freezer conversion projects on the web convinced me that the method does indeed work — e.g. running a freezer at refrigerator temperatures.

Like many folks, I do not have heaps of time on my hands for projects, and my woodworking skills are intermediate at best. I also wanted the kegerator in my family room so a measure of elegance was needed, and, as my large family needs all the space we can find, I also wanted to easily move the unit around as needed.

I found several inspiring stories about freezer conversions on the Web, including a forum thread where homebrewers showed off their kegerators. There were lots of different approaches and styles collected in one place. Armed with those ideas, I started planning . . .

"I quickly tired of bottling beer on the kitchen floor. What was once no big deal had become a pain in my backside, literally . . ."

### Guide to Parts

I found a black Frigidaire 7.2-cubic-foot chest freezer at Lowe's on sale for \$228.00. (This would be the most expensive part of the project, but starting from a new freezer rather than a used one gave me a perfect finish without spending a lot of time restoring it.)

I installed a wood collar between the freezer body and the lid, to increase the internal height so I could fit more kegs, and also to provide a surface that I could drill through for taps and such without fear of hitting a refrigerant line.

There is a debate among homebrewers which is better; the collar attached to the lid or to the freezer body. Perhaps the best argument for a collar-on-body installation (like mine) is that it is easier to build. One compelling argument for the collar-on-lid installation is that it is hard to lift a full keg over the collar into the freezer, so if the collar lifts with the lid there is less height to lift the keg over.

It is getting harder to find Cornelius kegs at bargain prices. I got two with a 5# $CO_2$ bottle and dual regulator for \$189.00 at kegconnection.com, and four more kegs from eBay for \$130.

I have wasted much beverage line by buying pieces that are too short. Eventually I found that I needed around 10 feet of 3⁄16" beverage line for each tap, serving at 10–12 psi. Anything less foamed excessively. If you're not sure, I recommend using online calculators to figure how much beverage line you need. For higher serving pressures you will need more. I coil the lines and wrap them with hook-and-loop straps usually used to organize computer cables to keep them organized.

### Parts and Supplies List

- Chest Freezer (Frigidaire 7.2 $ft^3$)
- Two pieces of 2-inch x 8-inch x 8-foot (5 cm x 20 cm x 2.4 m) lumber
- Foam panel, 1.5-inch x 24-inch x 96-inch (3.8 cm x 61 cm x 244 cm)
- PL300 foam panel adhesive
- Wood stain (I used Zinsser "Cabernet")
- Minwax polyurethane
- Four casters, 3-inch (7.6 cm), fixed and swivel
- Two Cornelius kegs (5#), $CO_2$ bottle, dual regulator, hoses and quick disconnects (w. hose barbs)
- Gas manifolds
- Beverage tubing, 3⁄16-inch x 40-foot
- 13 feet (4 m) of 5⁄16-inch gas tubing
- Four gas and four beverage ball lock disconnects FL, swivel nuts
- Love TSX-10140 temperature controller
- Masscool 120-mm fan
- Starr bottle opener with cap catcher
- Perlick 525SS faucets w. handles (4 pcs)
- 3-inch (7.6 cm) stainless steel beer shanks, (4 pcs)
- Ball lock kegs, 4 pcs
- Drip tray 19.25-inch
- 3M Scotch 4011 exterior mounting tape

This design for a freezer conversion is sylish enough for showing off in any room of your house.

## 1. REMOVE THE LID, INSTALL CASTERS

The lid hinges are spring assisted, so to avoid injury the hinges must be locked in place before removing them. Put a nail through the small hole to lock the hinge, then remove the bolts holding the lid to the freezer body and remove the lid.

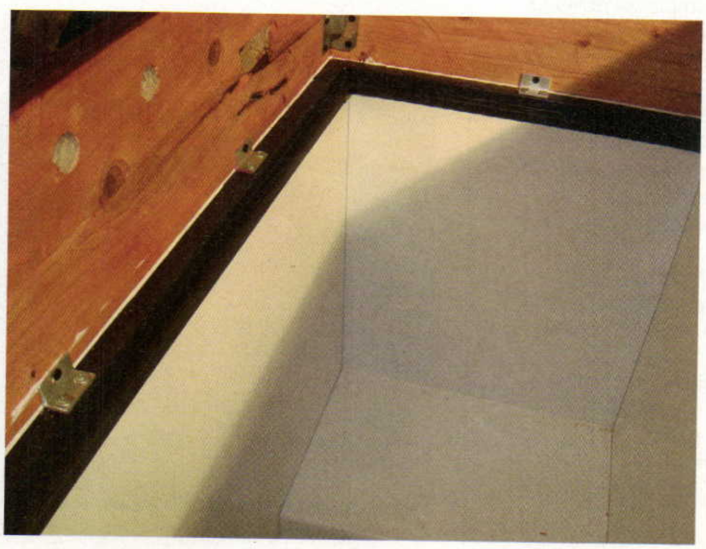
Flip the freezer upside down on a rug or a few pieces of cardboard. The metal frame is not rigid enough to support casters directly, so I installed 0.125-inch (0.32 cm) steel bar stock to reinforce it. Then I installed a pair of 3-inch (7.6 cm) fixed casters on the left side and a pair of swiveling casters on the right (from harborfreight.com).

## 2. BUILD THE COLLAR

There are two surfaces to hold kegs inside the freezer; the freezer floor and the compressor hump. The freezer floor can hold three Cornelius kegs without modification, but I was really looking to have four kegs. The compressor hump can hold one more, or possibly two, but the lid must be raised 7.25 inches (18 cm) for it to fit. As luck would have it, the height of a standard 2x8 board is exactly 7.25 inches (18 cm).

The lid seal, then, is 1 inch (2.5 cm) wide, so I needed at least that much width for it to seal against. The 2x8 is 1.5-inch (3.8 cm) wide, so it is also a good choice for that. I picked up some 2x8 boards at Home Depot.

I decided to thin down the boards to 1.25 inches (3.2 cm) because the lid seal requires only one inch, and there is an existing 0.25-inch (0.64 cm) round-over on the boards. Thinning down the boards maximizes the thickness of insulation that will fit inside the collar without interfering with the inside available area, and it also saves a little weight. This step is optional. You can also just use thinner insulation inside the collar. I built the collar on top of the freezer to make sure it would fit well and installed metal corner reinforcement inside the corners.



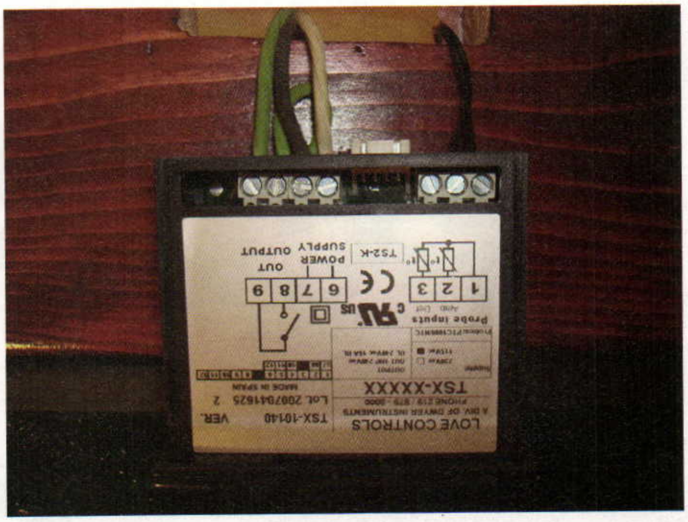
## 3. CUT HOLES, INSTALL CONTROLLER

I put the holes for the taps fairly high on the collar to place them at a convenient height. The holes are on 4-inch (10-cm) centers to fit my drip tray. I also cut a rectangular hole for the Love temperature controller (Dwyer Instruments, Inc). I used a 1-inch hole saw for the taps, but I later realized that a ⅞-inch saw is actually a better fit. After that you can stain the wood.

I worried that the collar would dislodge unless I firmly held it down to the freezer body, so I cut brackets, or cleats, from 0.75-inch (1.9 cm) aluminum angle bar. I placed the collar on a bed of adhesive caulking on top of the freezer body, then screwed the aluminum cleats in place. Each cleat has two screws going into the plastic top on the freezer body and one wood screw into the collar. The collar has a coat of polyurethane on the inside to resist moisture. I laid a bead of caulking inside the collar to make sure no moisture would wick underneath it.

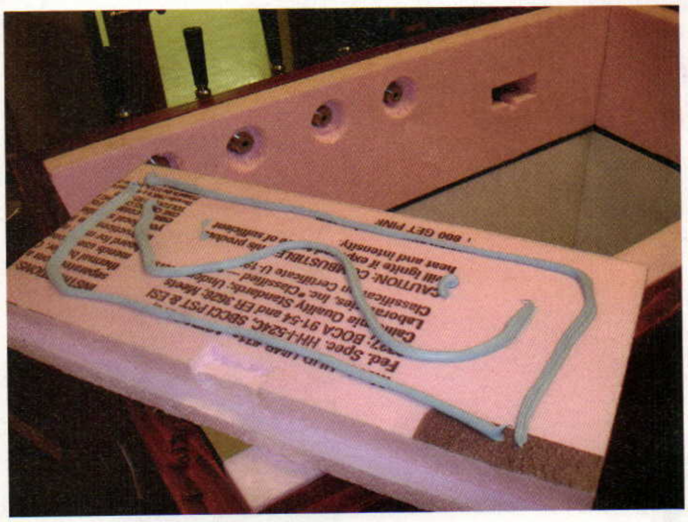
## 4. WIRING

**NOTE:** ***If you are not comfortable with electrical wiring, consult an electrician.*** You can also use a plug-in temperature controller, which does not need new wiring. The SJOOW-rated, three-conductor cable runs from the Love temperature controller (inside the collar) to the back, then out through the collar and down the back to the compressor compartment. The controller receives power on terminals 6 and 7 (black live; white neutral). There is a jumper (short green wire) between terminals 7 and 8, providing power for the compressor relay, and the compressor is connected to the controller's terminal 9 (green). Also shown is how to connect the included temperature sensor at terminals 1 and 2. In the compressor compartment I cut the wire after the original thermostat and inserted the new controller (terminal 9) in place. This wire provides power to the compressor, while the original thermostat provides power through the other cut end to the new controller via terminal 7. This way the original thermostat serves as a master switch by which all power can be turned off.



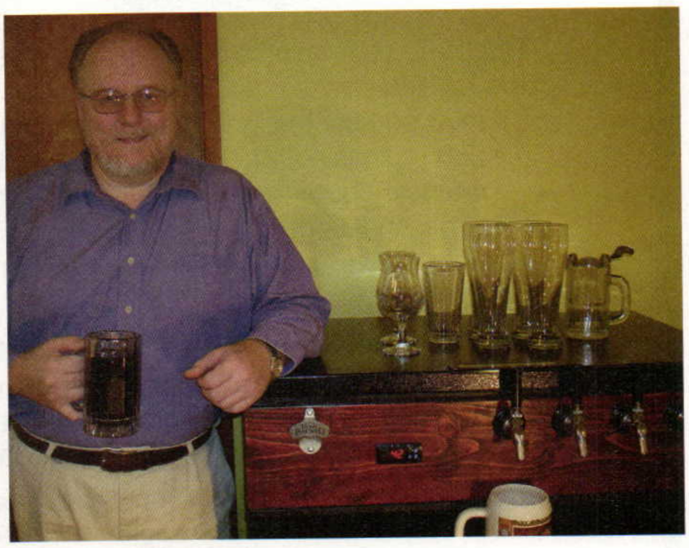
## 5. INSULATE COLLAR, INSTALL GAS MANIFOLDS

Unlike the freezer walls, the inside walls of the collar do not have refrigerant flowing through them. To make matters worse, heat rises and cold sinks, so that the warm air will collect under the lid in the collar area and the cold air will collect on the bottom. Why is this a problem? The faucets, and especially the beverage tubing, get heated by the warmer air in the collar, which makes the beer foam excessively. I have two remedies: first, I insulated the inside of the collar so that a minimum of heat will conduct from the outside in. Second, I installed a fan inside the freezer which will circulate the cold air from the bottom up. I used a 1.5" foam board to insulate the collar. Before installing the foam panels I installed 3" stainless steel faucet shanks since 3" shanks are a better fit than the more common 4" variety.



## 6. INSTALL DRIP TRAY AND BOTTLE OPENER, ASSEMBLE FAN

Drip trays can be very expensive. I found my 19.25-inch (23-cm)-wide drip tray on eBay for about $20.00, but you can find them in a variety of places online, such as www.micromatic.com. I also got three shelf brackets from a home improvement store, which I attached first to the drip tray and then to the freezer. The brackets are attached by heavy-duty double-sticky tape, 3M Scotch 4011 Exterior Mounting Tape, 1-inchx60-inches. Do not attempt to drill holes in the freezer wall because it is riddled with refrigerant lines. There are many different bottle openers available with various catching messages. The cap catcher is also attached with the exterior mounting tape. I have experimented with various placements of the fan, which is a 120 mm 12V computer fan I got from eBay, although you can find a similar sized fan at McMaster-Carr or Grainger. I used a 3-inch PVC sewer pipe with several holes drilled around the bottom perimeter using a 1-inch hole saw. The fan is fitted to the pipe by a rubber adapter I found at Home Depot. BYO



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# Seattle Taste

## "Rye PA" takes first place

**by Adam Robbings • Seattle, Washington**

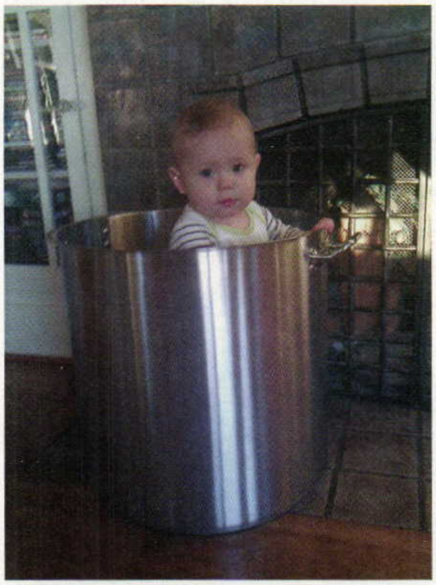
Though originally from London, I moved to Seattle in 2004. Originally, I was on a two-year transfer for work, but after meeting my wife, Grace, I extended my stay. We are now firmly planted here in the "Emerald City" with our eleven-month-old son, Reuben.

When I moved to the States I was worried that I would miss British beer, at least initially . . . but I couldn't have been more wrong. The craft beer industry in Seattle is absolutely so robust and thriving that I miss it when I go back to the UK to visit.

> "It was definitely intimidating when we were setting up next to Sierra Nevada, Deschutes, Ninkasi and 25 other breweries!"

After being in the US for about five years I started thinking about crafting beer myself. My young son kicked things off by buying me a homebrew starter kit for my birthday that year. (How did he know? He's very considerate!). I am now all-grain brewing and at a point where I am crafting my own recipes from scratch.

In July 2010, my wife Grace and I went to a local Beer Taste, (which is put on by the Phinney Neighborhood Association), which had around 30 local breweries and hundreds of people attending. Intrigued, we applied to be part of the next Beer Taste as homebrewers. We took four of our beers for their review and we were accepted to compete!



Adam Robbing's home brewery, Reuben's Brews, named after his son Reuben, can be found online at www.reubensbrews.com.

Trying to decide on what to brew for the event, I wanted to choose something that stood out but was not too extreme. I love IPAs (as does most of the Pacific Northwest) and I loved especially the idea of a black IPA. So, I decided on trying to make a winter IPA — taking a base IPA recipe and "warming it up" with roasty character and some rye. The result was a "Roasted Rye PA" recipe, in which I took a hoppy IPA recipe and added crystal rye and a small amount of chocolate malt to move it towards a black IPA. I brewed three 5-gallon (19-L) batches for the event and then kegged them.

With some bumps along the way, the day of the event came up quickly. It was definitely intimidating when we were setting up next to Sierra Nevada, Deschutes, Ninkasi and 25 other breweries! We started getting some great feedback from folks right away and hit a turning point that night. Word started getting around about our beer, and Grace was pouring and explaining it like a pro. All in all, we served around 200 beer tastes at the event! Without anything else, it would have been a great night, but, as we were packing to go, we found out that we had won first place in the people's vote for favorite beer. I haven't stopped pinching myself since!

### Reuben's Hopmonster IPA
**(5 gallons/19 L, all-grain)**

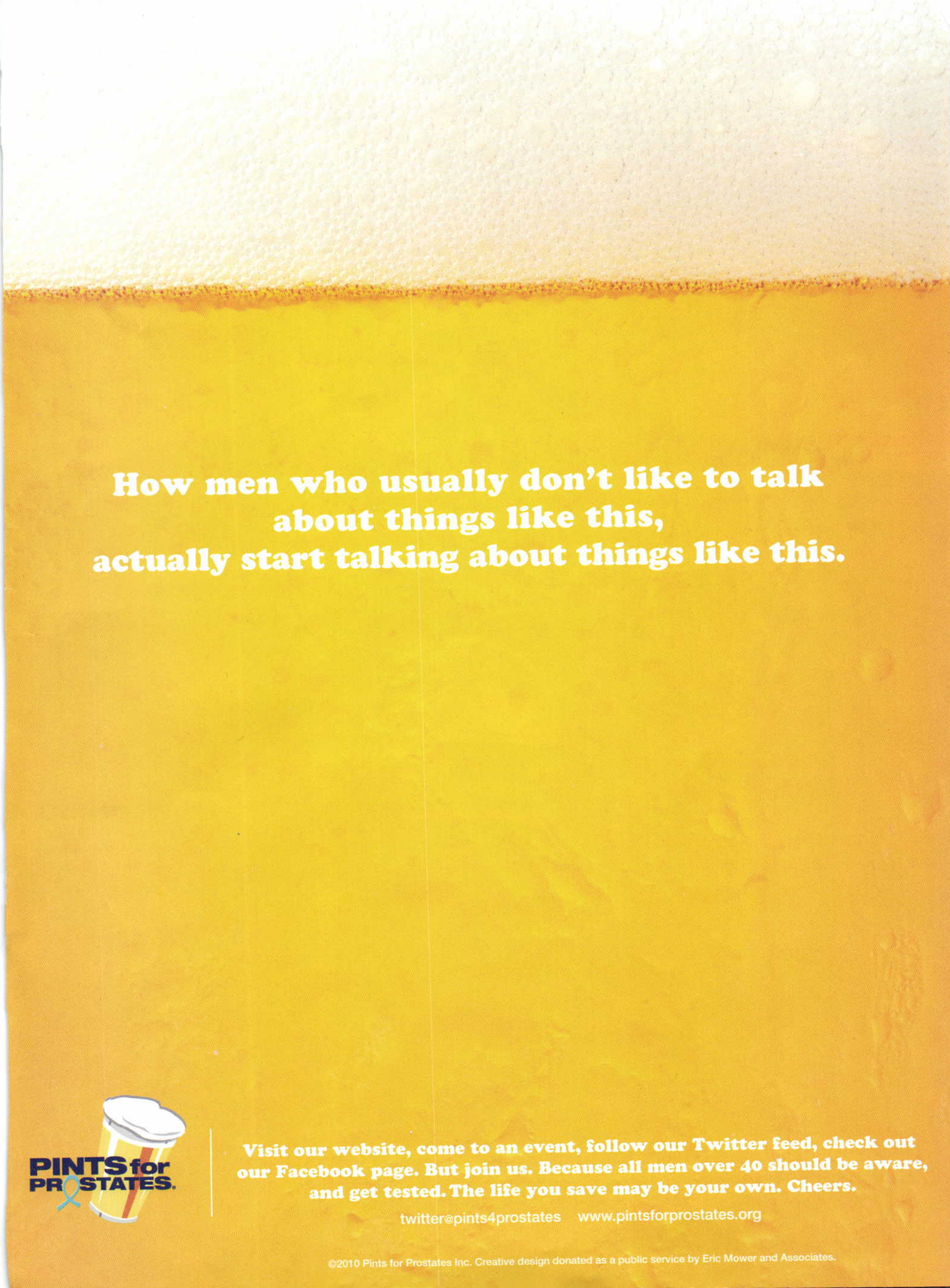
70% efficiency assumed
OG = 1.065 FG = 1.016
IBU = 100+ SRM = 8 ABV = 6.2%

### Ingredients

12 lb. (5.4 kg) US 2-row pale malt
4 oz. (113 g) Carapils® malt
4 oz. (113 g) crystal malt (10 °L)
3 oz. (85 g) crystal malt (40 °L)
28 AAU (2 1/8 oz.) Chinook hops (60 min.)
1 oz./28 g (60 g) Amarillo hops (20 min.)
1 oz./28 g Cascade hops (5 min.)
¼ oz./7 g Centennial hops (5 min.)
¼ oz./7 g Chinook hops (0 min.)
¾ oz./21 g Amarillo hops (0 min.)
⅛ oz./3.5 g Amarillo hops (dry hop)
⅞ oz./25 g Centennial hops (dry hop)
White Labs 001 (California Ale) or Wyeast 1056 (American Ale) yeast

### Step by step

Mash for 1 hour at 152 °F (67 °C). Boil for 60 minutes, following the hopping schedule in the ingredients list. Chill the wort rapidly to pitching temperatures and pitch the yeast. Dry hop for up to two weeks in a secondary fermenter. BYO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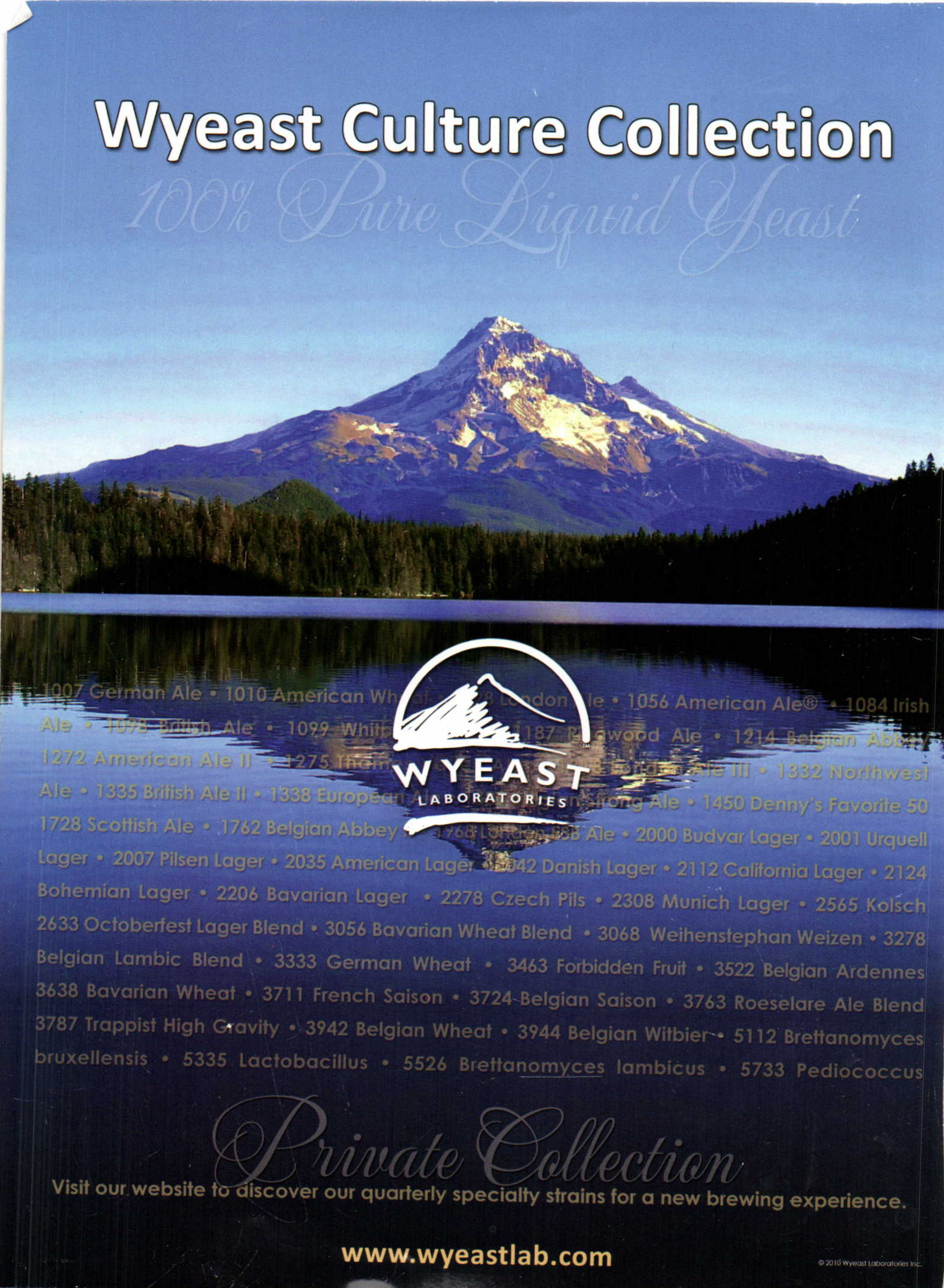

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