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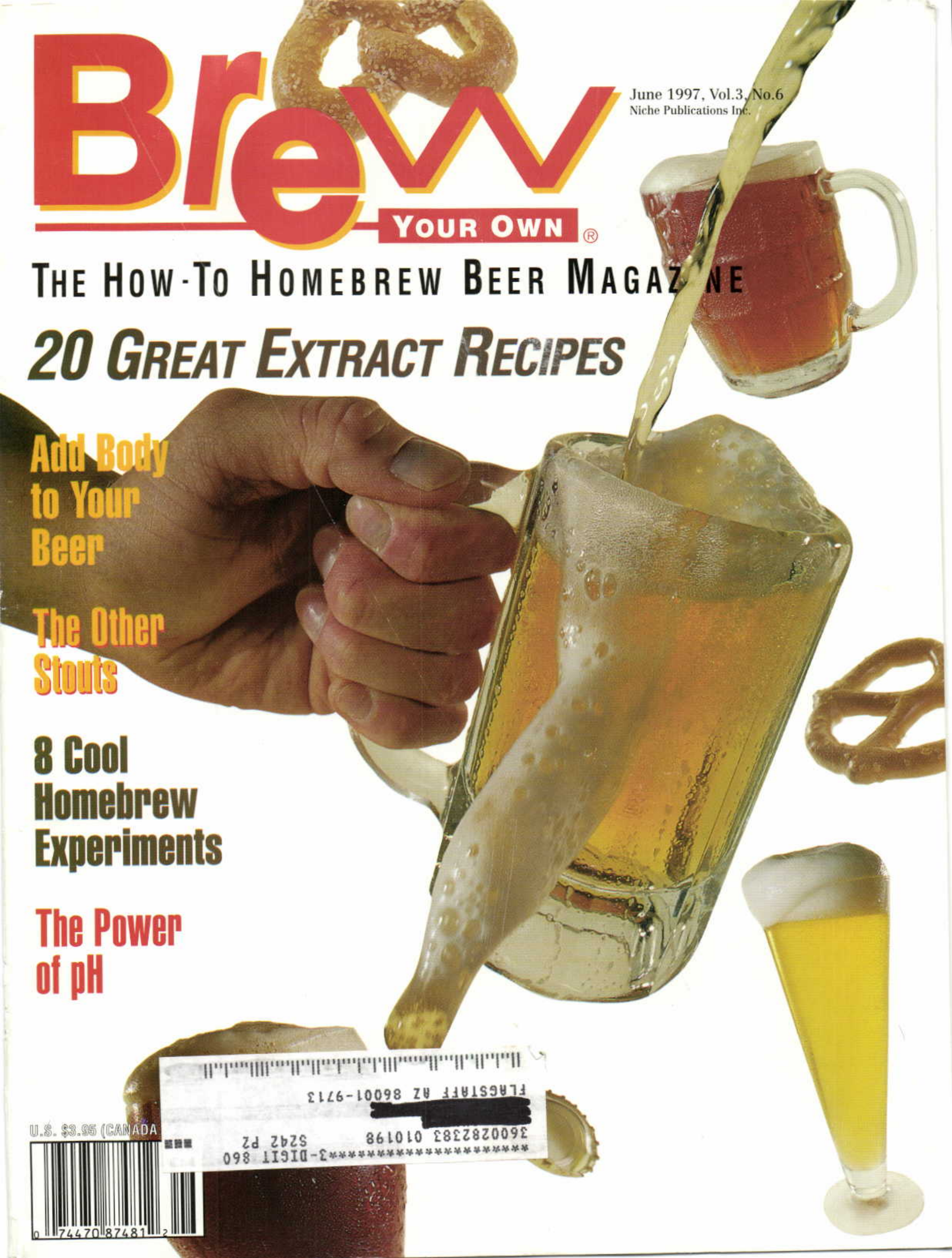
Brew YOUR OWN®

THE HOW-TO HOMEBREW BEER MAGAZINE

20 GREAT EXTRACT RECIPES



Add Body to Your Beer

The Other Stouts

8 Cool Homebrew Experiments

The Power of pH

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Boston Ale
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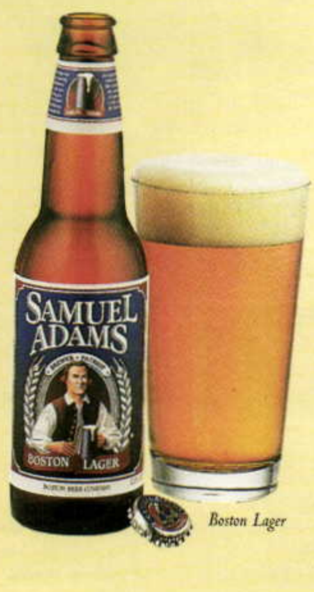
Scotch Ale
Triple Bock
Cherry Wheat
Double Bock
Octoberfest
Cranberry Lambic
Winter Lager
Old Fezziwig


Grant Wood
Jim DeBoer
Richard Dube
Walter Scheurle
David Grinnell
Jim Koch
Jose Ayala
Jim Pericles
William Reed (not present)


SAMUEL ADAMS
BOSTON LAGER
Boston Lager

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Cover photo: Kent Lacin

Experimental Science

You can brew great beer without knowing a thing about science, but I find the more I brew, the more I want to learn about the science behind the process. Still, I would never dream of calling myself a scientist. That title holds a sort of mystical bearing for an English-major type like me. I'm more of a pseudo-scientist. Here's the difference:

Scientist: uses a microscope. Pseudo-scientist: squints.

Scientist: measures everything carefully into beakers and test tubes. Pseudo-scientist: knows there are 16 ounces in a pint.

Scientist: can name the Noble Gasses. Pseudo-scientist: can turn on the gas stove.

Scientist: knows the value of pi to six digits. Pseudo-scientist: knows the value of pie.

Pseudo-scientist: dreams of \$1,000,000. Scientist: dreams of $\$10^6$.

Scientist: uses control groups to test one element at a time. Pseudo-scientist: demonstrates control by not drinking the beer more than a week or two before it's ready.

I blame my lack of science prowess on my high school teachers. Chemistry class, for instance, consisted of hours of boredom broken only by the occasional moments of excitement when we were able to "accidentally" light something on fire with the Bunsen burner.

Teacher: "Now class, record the temperature every 30 seconds, then we'll chart a graph to calculate..."

Budding pseudo-scientist: "Look! Joey's notebook's burning and the flames are green."

At least in biology we got to dissect frogs. But that only lasted one day, and we had to talk about it for two weeks before and two weeks after.

Maybe this is all hindsight, but it seems to me science would have been a lot more fun if we had learned to brew. Think about what a hit that would be. You could learn about the biology of the barley and the malting process, you could learn about mash chemistry, and you could even practice your temperature-taking techniques and plot a graph of the boil. Not only that, at the end you've got something to show for your efforts.

Not, of course, that I'm in any way advocating that young people under the age of 21 illegally consume alcoholic beverages that might corrupt their minds. Sure, many European countries approach alcohol consumption in a sensible, balanced way, with kids learning to drink moderately with meals at home. And just because those countries have remarkably lower rates of alcoholism and societal drinking problems, that doesn't influence me a bit. It would never work here. No, that stuff should go straight to the teachers' room.

This month we offer some homebrew science experiments for even the English majors among us. Author Alex Fodor, who as a graduate of the masterbrewers program at the University of California, Davis, knows a thing or two about beer and education, presents some simple ways to make your beer better tasting to the one who matters most — you.

He details eight experiments that will help you in a very practical way select the right yeast and hops, the hopping procedure you like best, even the best bottles for your beer. No science teachers necessary, and we guarantee you won't blow anything up. The story begins on page 42.

Brew Your Own
THE HOW-TO HOMEBREW BEER MAGAZINE

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Stories Behind the Labels

Richard Anderson
St. Paul, Minn.

Gladstone, as in Gladstone Brewing, consists of three determined and focused individuals dedicated to being "the best they can be" in brewing a quality product for personal consumption. It is a family-oriented operation consisting of my father-in-law, Masterbrewer Dr. Robert Jones; brother-in-law James Jorissen; and me, the assistant masterbrewer. Annual brewing capacity runs about 70 gallons and fluctuates depending upon professional and family obligations.

We picked the name Gladstone because the area in which we live was once called Gladstone Township. It is now a suburb called Maplewood. William Ewart Gladstone was a four-time prime minister of England during the Victorian era. We thought it only right to pay homage to all the fine English ales we try to produce by placing Mr. Gladstone's picture on all our labels and naming our "brewing trio" after him and the local township.

The reason we have included the reference to Milwaukee on the label is that Assistant Masterbrewer Jim Jorissen had moved to Milwaukee because of a career decision. Our brews are now being consumed in two large American cities — how many other homebrewers can claim that?

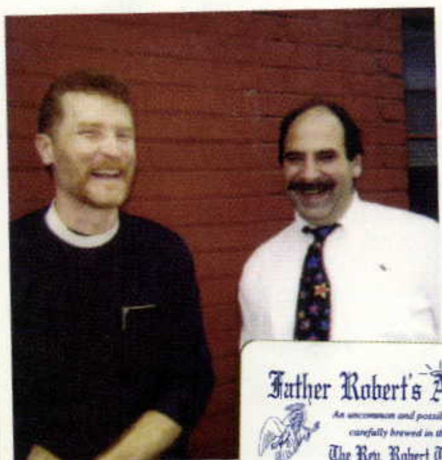
Three brewers, Richard Anderson, Robert Jones, and James Jorissen, toast Gladstone Brewing.

Robert T.J. Childers
Anniston, Ala.

I am an Episcopalian priest, which is where "Anglican Brew" comes from. The Episcopal Church in the United States has its origins in the Anglican Church in England.

I have a friend who is a printer, and whenever I brew a new batch, I give him a six-pack to sample. As a thank you and incentive to keep the samples flowing his way, my friend designed labels for my brews.

The beer is brewed in a room off of my garage. It has some or most of the qualities that the label claims.



Priest and homebrewer Robert Childers makes sure his friend, Frank Musso, is well supplied with homebrew. After all, any priest knows it's better to give...

Brewing In Style!

What's the strangest outfit you've worn while brewing? Tell us about it and send us a picture. There's a cool BYO T-shirt in it for you. Send your story to Pot Shots, c/o Brew Your Own, 216 F Street, Suite 160, Davis, CA 95616. Or send us e-mail at edit@byo.com. Be sure to include your mailing address!

Even More Couples Who Brew

Better than scaling a sheer rock face, more fun than a 500-mile bike ride.

Cheri Stewart
Nashville, Tenn.

You cannot imagine the look on my face when my husband, Bart, announced we would start brewing our own beer. You see, it is more often than not that my dear husband decides on a new hobby requiring a large buy-in, several magazine subscriptions, expensive equipment, and endless hours of discussions on how he will be the best at whatever the hobby of the month is. I have bicycled 500 miles across Georgia, in-line skated until I could not move, learned to ice skate, and hung upside down from a rock face held only by a rope attached to my waist in an attempt to please my husband. Homebrewing, I thought, what a ridiculous idea.

It wasn't enough to purchase the brewing kit from the homebrew store; my husband had to buy each piece individually to ensure quality, and we ended up with fewer pieces of equipment and spent $100 more than the kit cost. Of all the things $160 could have bought, we end up with cruel-looking tubes, dirty beer bottles, a stupid glass jug, plastic spoons, and plastic bags filled with smelly stuff. Oh boy, I thought, here we go again.

The night of the big brew, sensing some lack of interest on my part, my husband purchased our favorite microbrewed beers, ordered a pizza, and rented "Animal House" to set the mood.

I assisted in sanitizing and stirring, and he explained each step as we sipped our beers in frosty mugs. I was a little leery when he dropped moss in the brew, but he assured me this was the way real brewers did it. This was actually becoming fun. I was learning all about how real beer was made and we were spending quality time together. The brewing and clean-up were not messy at all, and we sat down to watch the movie and eat pizza, marveling at how cool we were to be homebrewers.

Peeking into the guest bedroom daily to check on the fermentation, I was becoming more and more excited about how the homebrew would taste. My husband suggested I tap into my artistic nature (no pun intended) and draw some labels for our beer. I spent two days designing and coloring the labels, which my husband proudly showed off to his friends (who could not get their significant others involved in this hobby).

The day we bottled the beer involved another trip to the brew store for more equipment and more money spent, but at this point I didn't care. When the beer was poured into the bottling bucket, the smell was absolutely breathtaking; it smelled like real beer! My husband poured two glasses of the warm, uncarbonated beer, and we sipped our creation. To my surprise it was delicious and tasted just like Killian's Red. "Imagine what it will taste like when it is cold and carbonated!" my husband cried. We bottled and pasted on the labels, and our creation finally had a name. I finally knew what all the excitement was about.

I now exclusively drink homebrew and can actually talk intelligently to you about its hoppiness and its nose. I subscribe to *Brew Your Own* and am ready to join the local brew club. A note to all the wives and girlfriends out there: Take a minute to listen to your husband or boyfriend explain his homebrewing and get involved. It is not only fun but also a great way to spend time together.

Pat Schroepfer
Lafayette, Colo.

I have been homebrewing since 1989. I brewed with my high school buddy until he moved out of state. Brewing alone isn't all that bad, but you have nobody to talk brew lingo with.

I tried several times to get my wife to brew with me, but it just didn't interest her until I brewed a batch of American Light Ale. This beer did something for her. After it was nearly gone, she wanted me to brew another batch for her. I thought, "No problem, but you are going to help." I gave her a basic crash course on brewing and sanitizing and had her clean the equipment and measure out ingredients.

She took to this new hobby. To this day she has advanced and become a more knowledgeable homebrewer. Come fall she can't wait to brew a batch of American Light Ale.

Felice Bogus
White Plains, N.Y.

My husband has been an all-grain brewer for a number of years and by all accounts his beer is pretty good. I really prefer it when he finds a friend to brew with, though, since I think the mash smells like week-old boiled brussels sprouts and I'd rather be out of the house, but I'm not always that lucky.

Not only is Bob unable to smell the mash, he can't smell bleach. So I have to sniff the sterilized bottles. "Smell this bottle. Does this smell like chlorine?" Brewing in our house means Bob sweats over the stove and I have my nose in a bottle. I wouldn't even mind it so much if I were a beer drinker.

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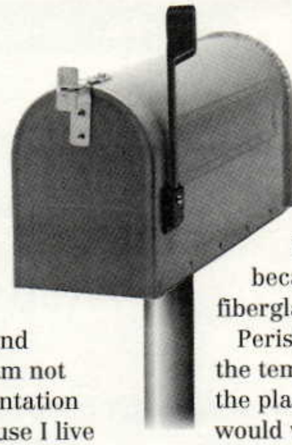


Dear Brew Your Own,

I read "Brew Julius Caesar's Beer" (March '97 BYO) and loved it! I'm into beer history and I try to stick to the historical recipes and brewing methods, although I am not about to try an open-air fermentation from airborne wild yeast because I live in a large, polluted city. Should I just go ahead and bottle my version of Julius Caesar's beer as usual? Also, how long should I ferment and how long should it age?

Chris Stone
Philadelphia

You are wise not to try open fermentation. Even if in an unpolluted area, you don't want to waste your ingredients on the wrong wild yeast. The beer historically would be fermented until there was no noticeable action from the yeast and racked into large holding containers that would be suspended from the rafters. This would make it easier to tip the container to pour. If there were no rafters, then a large clay pot sitting on the floor would do. Serving jugs could be dipped into the beer before the beer was served.

If the beer was to be transported, it would not go far. The beer was consumed fresh; there was no way to stop it from oxidizing. It was also served at room temperature. Storing it in the coolest part of the building would help.

How to consume it: Get a good grip on the mug, lift, and line it up with your mouth. Open up and pour.

Dear BYO,

I enjoyed the article "Pump It Up" (April '97 BYO) about the use of pumps. What make and model of pump might I select for a RIMS brewing setup?

The pumps available through Grainger or MacMaster Carr are rated for the temperatures that do not exceed 150° F. In the sparging cycle the temperature will be about 170° F and hot wort may be near 212° F.

The limitation is based on the plastic material of construction. One homebrewer suggested a Master pump that I am not familiar with. He reported that it withstood the higher temperature because it was made with fiberglass in the plastic.

Peristaltic pumps depend on the temperature tolerance of the plastic tubing. What tubing would withstand 212° F, Tygon?

John E. Thompson
Monee, Ill.

Based on RIMS literature and some thorough Internet postings, temperatures up to 180° F are as high as could be encountered by a pump used in RIMS. Grainger sells Teel brand chemical-solution pumps that are good up to 180° F, which should be adequate. The pump with part number 1P676 will work. These are centrifugal pumps with a glass-filled polypropylene housing.

Ryton plastic (polyphenylene sulfide) also withstands such high temperatures. Pumps made from both of these materials are found on pages 878 and 879 of the 1997-1998 Cole-Parmer catalog.

Tygon tubing will not withstand the temperature range, but the food-grade, polypropylene-based Norprene tubing will work at temperatures up to 275° F. Cole-Parmer sells this tubing.

You've asked about pumping liquids at temperatures up to 212° F. You must be thinking about recirculating the hot wort through an external chiller after your boil. Remember that regardless of the pump temperature tolerance, one should not attempt to pump near-boiling liquid through a centrifugal pump. The vacuum created at the pump inlet can cause the liquid to boil, which can damage the pump.

To chill your wort, you could wait until the wort cools somewhat, then use the pumps described above to pump the wort through the external chiller. Or you could use an immersion chiller, similar to that described in the article.

With a suitable piping arrangement, you could remove the centrifugal pump from the wort circulation loop and use it to recirculate the cooling water.

The Czar of Hybrids

by Scott R. Russell

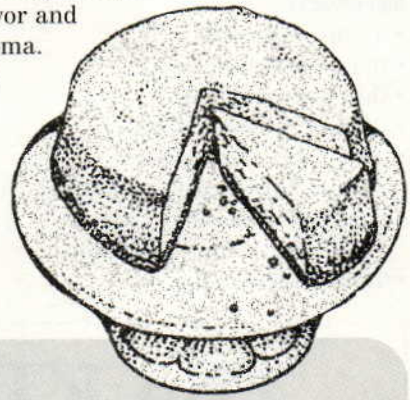
So this guy walks into a bar and says to the bartender...No, let me start over. Seems there's this guy sitting in a bar, yeah, that's it, and he asks the bartender for...

Umm, well, the guy was me, of course, and what you are about to read is a true story. The names have been omitted, because no one is really innocent. Besides, I can't remember the names. Anyway, on one side of me someone ordered a beer. A pale ale, light amber to deep gold, depending on whether you're an optimist or a pessimist. Hops in the nose, hops aroma for five feet in any direction. A bit of butterscotchy diacetyl too, but that's okay among friends.

I'm still thinking, haven't ordered anything yet. The bartender is drinking a cup of coffee. She's on duty, no beer for her until her shift ends. Coffee aroma is sweet, rich, hint of vanilla, maybe? Yes, it's French vanilla coffee. With cream and a little sugar. Coffee beer? Been there, done that, many times. Always nice, but let's come up with something new.

Down the bar, someone's dessert arrives. Hot fudge brownie cheesecake, or something lethal like that. Overwhelming dark chocolate aroma, burnt and bittersweet. Eureka. The Czar of all hybrid beers: White Russian Imperial Pale Ale.

One of my greatest pleasures in brewing is fooling people: presenting a new beer to people without telling them what it is, and watching their expressions as they realize that it isn't exactly what it looks like. This beer is a classic for that, because it looks like an ordinary pale ale, on the light side of the style (especially when I brew it all-grain instead of from extract) but with a high alcohol content and rich chocolate/coffee flavor and aroma. It's



White Russian Imperial Pale Ale
(5 gallons, extract and specialty grain)

Ingredients:

- 0.5 lb. cara-pils malt
- 0.5 lb. malted wheat
- 8 lbs. extra light unhopped dry malt extract
- 2 oz. Target hop pellets (8% alpha acid), for 45 min.
- 1 oz. Styrian Goldings hop pellets (4% alpha acid), 0.5 oz. for 15 min., 0.5 oz. after boil
- 10 to 14 g. dry ale yeast or liquid culture (Wyeast 1098)
- 5/8 cup corn sugar
- 0.5 lb. dark roast coffee beans
- 2 cups white crème de cacao

OG: 1.070 to 1.075

Step by Step:

In 3 gals. of cold water, steep malt and malted wheat. Heat to 170° F and remove grains. Sparge with 1 qt. or so hot water into kettle. Add malt extract. Bring to a boil. Add Target hop pellets, boil 30 minutes. Add 0.5 oz. Styrian Goldings pellets. Boil 15 more minutes, turn off the heat, and add the other 0.5 oz.

Chill, top up in fermenter to 5.25 gals., and cool to 75° F. Pitch yeast at 70° F until active, then ferment cool (55° to 60° F) for eight to 10 days, rack to secondary, and condition cool for three weeks.

A few days before bottling, coarsely crack coffee beans and steep in enough cold water to cover them completely in a covered jar. Add in a few Styrian Goldings pellets if you want to add a dry-hopped touch to the beer. Shake occasionally. At bottling, prime the beer with corn sugar and add the coffee extract, pouring it through a fine mesh strainer or several layers of cheesecloth. Add crème de cacao and gently stir in the flavorings. Bottle and age two to three weeks. Serve at cellar temperature (50° to 55° F).

All-grain recipe:

Mash 9 lbs. pale malt and 2 lbs. mild ale malt in 15 qts. water at 152° F for 90 minutes. Steep cara-pils and wheat (as above) in mash runnings. Sparge with 12 qts. water at 169° F. Proceed with boil and hopping schedule as above, reducing to 5.25 gals.

Notes:

The use of white crème de cacao, as well as the cold extraction of the coffee, is a means of getting that surprising coffee and chocolate flavor and aroma without darkening the beer. Obviously, if you want to make this a darker beer you can add crystal, chocolate, or black malt and use any means you can think of to get the chocolate and coffee into the beer.

If you are not afraid of a bit more intensity, chop up a vanilla bean and steep it in hot water for a couple of hours before bottling. Add this vanilla tea with your priming sugar.

quite smooth, too, so be warned: It goes down very easily.

Reader Recipes

IPA from Holland
(5.3 gallons, all-grain)

I want to let you know that there are lots of all-mash brewers in Holland, too. Here's my prize-winning IPA. Well, it wasn't a first prize but it was the first after two years of experimenting, flushing down the drain, and trying again.

Ben van Velzen
Amersfoort, Netherlands

Ingredients:

- 10 lbs. pale malt
- 0.5 lb. flaked barley
- 0.5 lb. crystal malt
- 0.06 lb. roasted barley
- 1.8 oz. Challenger hops (8.5% alpha acid), for 60 min.
- 0.9 oz. Kent Goldings hops (5% alpha acid), for 15 min.
- 1 tsp. Irish moss
- 1 tsp. calcium sulphate
- EDME yeast
- 1/2 tsp. white sugar for priming

Step by Step:

Make a yeast-starter of 0.5 qt. water, boiled with 2 tbsp. of light malt extract. Pour it in a sterile bottle, cool it down to 75° F, add the yeast, and plug it with a cotton ball. Let it stand in a warm (68° to 79° F) place for one day. Because the water in Amersfoort is very soft, one must Burtonize the water (hence the need for calcium sulphate) to get the typical hardness of IPA. Grind the malt and barley except for the flakes.

Mash in grist at 4.75 gals. water at 99° F. Raise temperature to 113° F with a rest of 15 minutes. Raise to 131° F with a rest of 30 minutes. Raise to 149° F with a rest of 60 minutes. Raise to 158° F. Check iodine test. If positive, rest for about 30 minutes. Raise the temperature to 172° F. Strain and sparge with water of 172° F until your OG falls to 1.020. Boil. Add the Challenger hops after 15 minutes. Boil for another hour.

Add Kent Goldings hops and the Irish moss and boil for 15 more minutes. Let it stand for 15 minutes, strain into the fermenter, and cool it rapidly. OG must be 1.060. If too low, adjust with sugar. If too high, you will be praised by your fellow brewers!

Add the yeast starter and cover with a clean cloth. Ferment down to 1.025 and rack into a carboy and let stand under airlock until clear and fermented down to 1.010. Clean bottles and add sugar for priming. Store in a cool place for about five weeks (or longer if you can wait so long). I don't know how long it lasts, because I'm not that patient.

Saison Dupont Clone
(5 gallons, all-grain)

This beer is a real drinking experience for those adventuresome beer lovers out there. Its fruity, spicy palate and dense, creamy head are something to contemplate. Beware, it can become addictive. Its character will continue to grow, and it will not reach its peak until it has been in the bottle for at least four months.

British pale malt also works well in this recipe with a 158° F single-step infusion mash.

Barry Johnson
Watertown, Conn.

Ingredients:

- 12 lbs. Belgian pilsner malt
- 1 tsp. gypsum (2 tsp. if you have soft water)
- 1 to 1.5 oz. Hallertauer hop pellets (6.6% alpha acid), for 60 min.
- 1.5 oz. Kent Goldings hop pellets, 1 oz. at end of boil, 0.5 oz. in secondary
- 1/2 tsp. Irish moss
- 1 cup corn sugar for priming
- Yeast cultured from bottle of Saison Dupont or Brewers resource CL-380 Saison culture in 1 qt. starter

OG = 1.056 to 1.060
FG = 1.008 to 1.010

Step by Step:

Use three-step infusion mash. On stovetop mash grains in 13 qts. gypsum-treated water at 130° F. Add heat if necessary to settle mash at 120° F. Hold for one-half hour. Raise temperature to 158° F. Hold for one hour or until iodine test is negative. Raise temperature to 168° F to deactivate enzymes. Sparge with 170° F water to collect 6 gals. of sweet wort. Boil wort for 1.5 to two hours, adding Irish moss one-half hour into boil. Add boiling hops one hour before end of boil. Add aroma hops at end of boil. Add water if necessary during the boil to maintain a volume of 6 gals. in order to end up with 5 gals. of fairly clear wort after cooling. Cool and pitch prepared yeast starter. Ferment at 70° F. Check specific gravity after one week.

If fermentation seems to have slowed at mid-gravity, gently stir the yeast at the top of the fermenter back into suspension with a sanitized spoon. When the yeast begins to settle, which may take two weeks, rack to a secondary fermenter, adding the dry hops loose. Leave in the dry hops for at least two weeks. Bottle the 5-gal. volume with corn sugar when gravity is between 1.008 and 1.010. Age for two weeks in a warm, dark place to carbonate. Transfer to cool area to age further. Serve just chilled in an appropriate glass, and try to age some for at least four months if possible. It will be worth the wait. ■

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We want your recipe for Recipe Exchange! If we print it, we'll send you a spectacular *Brew Your Own* T-shirt! Send it to Recipe Exchange, c/o *Brew Your Own*, 216 F Street, Suite 160, Davis, CA 95616. Or send e-mail to edit@byo.com. Be sure to include your address and phone number.

Curing Sluggish Carbonation

Mr. Wizard

I read a suggestion that homebrewers should remove the cold trub from the wort about six hours after pitching the yeast. Although I'm familiar with the saying "if it ain't broke, don't fix it," I decided to try something different. For the past year, after cooling the wort with an immersion chiller I pitch the yeast and allow the wort to settle for about four hours in a six-gallon bucket. Then I transfer the wort to a 6.5-gallon glass carboy for primary fermentation. Once the primary is complete I transfer to a five-gallon carboy for secondary fermentation for the remainder of a month, then bottle.

It seems that carbonation in my bottles is becoming uncertain, often stuck. When this happens I move the bottles to a warmer location for a week, shaking occasionally. This seems to do the trick.

George O. Proper
Albany, Calif.

Your carbonation problem sounds like it may have nothing to do with the new method of fermenting and may simply be related to the temperature at which you have been holding your bottled beers during conditioning. For fast and reliable carbonation, especially with ale yeast, it is best to hold the bottles at room temperature for seven to 14 days before cooling them down. I don't know if you have altered your conditioning process to go along with your new method of fermentation, but if you have given the entire process a face lift, you may have been a little overzealous.

Another possibility is that your new method of fermentation and conditioning is working well; it clarifies the beer during the process. This means that dead yeast and trub introduced early in fermentation have been left in the settling vessel, and the yeast deposited in the primary is more or less free of cold trub and dead yeast. In the absence of the sludge that is left in the settling tank, the yeast in the primary may be flocculating better, but that is merely a possibility. It also sounds like you have an extensive stay in the secondary fermenter, which would tend to further clarify your beer. The result of all of this gravity clarification may be a beer that contains insufficient yeast for carbonation purposes or at least insufficient to carbonate the way you originally were accustomed.

Although insufficient yeast for carbonation can happen, it is very difficult to really remove that much yeast without filtration. It is, however, fairly easy to change the yeast concentration enough to affect the rate of carbonation. According to your letter the beer is eventually carbonating, albeit after a little persuasion.

My advice is to evaluate the beer flavor. If the new method has improved your beer flavor and improved the appearance, I would be tempted to continue using it. If the only thing it seems to do is let you watch the fermentation and make carbonation a bit trying, I would be tempted to try something different.

The last resort to this sort of problem is to add fresh yeast at bottling time. This method works very well and there is nothing wrong with the practice. It provides healthy, fresh yeast that usually carbonate beer much more quickly compared with the old, cranky yeast carried over after aging.

I consider this a last resort because most homebrewed beers have plenty of yeast to carbonate beer in the bottle and adding more yeast will only increase the yeast load.

If the finished beer is very clear, then a small addition of yeast, about 5 percent of a proper pitch for primary, will provide plenty of yeast for carbonation. A proper pitch for primary is about 14 grams of dry yeast or about one cup of thick slurry harvested from a previous fermentation.

Mr. Wizard

I'm confused! What is the difference between Laaglander, Hugh Baird & Sons, Briess, Munton and Fison PLC, and klages dry malt? My homebrew-supply store only sells Munton's dry malt and says there is no difference. Also, what is the difference between two-row and six-row?

Patricia Meahl
Yulee, Fla.

This is one of those short questions that begs for a treatise on malt and barley that will have to be saved for a rainy day. In the meantime I think I can answer your question in a more practical manner.

Because all of the brands of dry malt extract (klages is a barley variety, not a brand, but I'll get to that later) cited in the question are not made in the same country, I would not assume they are the same. The reason behind this is that most pale malts in the world are made to certain specifications that usually have much to do with who buys the malt.

In this country, for example, Anheuser-Busch has more influence on brewing raw materials, especially malt, than most brewers could

imagine. Much of the influence has been quite good, because all malt houses that sell some of their malt to A-B must meet very high standards of quality. Since A-B buys malt from all of the large domestic maltsters, it has affected many companies.

One side effect is that pale malt in the United States is very, very pale because that is what all the big guys want. Craftbrewers and homebrewers grumble about this, but economic pressures tend to be blind; the one with the most buying power gets what he wants and everyone else gets the same thing! This means that US pale malt often lacks the malty, nutty, and biscuity flavors of darker pale malts, such as pale ale malt.

In the United Kingdom the standard pale malt tends to be a little darker than US malts because UK brewers want darker malt and that's what they get. This same argument could be made for every country in the world, but I think I've made the point.

Briess is an American company, Munton's and Baird are both British, and Laaglander is Dutch. If my unified theory of malt comparability is applied to this question, then it must be concluded that these products are not the same. What can be concluded, however, is that these reputable companies are all capable of producing a consistent product. That means that you can pick the ones you like and feel confident that their products will always be more or less the same.

There is a catch to this blanket don't-worry statement and that is variety. Klages, for example, is a barley variety with certain properties. Most of the properties in malt made from klages barley are very much liked by brewers, but farmers don't like klages because it does not yield as well as other varieties and has some other agronomic problems not shared by other barley varieties. This means that there isn't much klages malt in the country, and you can bet your bottom dollar US companies that make dry malt extract are not buying up a limited variety to turn into extract.

There are two key points to glean from the issue of variety. The first is that barley variety does affect malt quality and hence beer quality. Because all the barley-growing regions of the world don't all prefer the same barley variety, maltsters of the world are using different varieties!

Second, the farmer is as important, if not more important, than the brewer when it comes to selecting varieties. No matter how good the malt is, if the farmer is unwilling to plant a given barley variety there will not be any malt from that particular barley variety. To make these points worse, farmers change varieties very frequently as new and improved varieties are continually being released that have higher yields, better disease resistance, better harvesting performance, and other benefits. For this reason commercial brewers, maltsters, and barley farmers work together to help each other out.

In North America both six- and two-row barley are grown, and in Europe only two-row varieties are grown. Six-row varieties have three fertile florets (kernels) at each node on the plant's rachis (the part the kernels are on). When the head is viewed from above the rachis, there appear to be six rows of kernels because each triad of florets is offset down the rachis.

In two-row varieties there is only one fertile floret per node and, like the six-row varieties, this position is offset, giving the appearance of two rows. Big deal! Well it kind of is because the two-row floret has more space to expand on the ear. This means two-row barley tends to be plumper than six-row, and plumper means more extract and less protein. Another difference is that six-row varieties have higher enzymatic power.

In general all-malt beers are made with two-row varieties because many brewers feel these varieties are best for flavor and because there is already plenty of enzyme for all-malt brews. More enzymes usually means more protein, and more protein means less carbohydrate, which is really why we mash to begin with!

The key thing is beer flavor. If the malt makes good beer, it really doesn't matter if it is two- or six-row, comes from Europe or North America, is klages, harrington, or 1202, has a wrinkled or smooth ventral furrow with short or long rachis hairs, and has a blue or white aleurone! And by the way, pleeeeeease, nobody ask what a blue aleurone, a rachis hair, or a ventral furrow is; I don't want to embarrass any barley kernels that may read this column.

Mr. Wizard

I have been harvesting yeast from my primary fermenter, washing it, and storing it for repitching (I save a lot of money on liquid yeast purchases). However, I have been brewing more varieties, hence using different strains of yeast. Now I have about six varieties of yeast.

Should I be concerned about the yeast autolyzing? (And just what is that, anyway?) If so, will it cause any off-flavors in the beer? How long can I successfully store yeast in the fridge and successfully use it to re-pitch? Also, how may times can it be reused before mutation presents a problem? I have successfully been able to remove the trub by washing the yeast, so I have about one-fourth inch of white yeast under sterile water.

Tom DiVittorio
Houston

Considering the number of times I have stressed the convenience of reusing yeast, I am surprised this is the first time this question has come up because it is a very important topic.

In general hanging onto your yeast for extended periods of time does nothing more than allow it to die.

However, if one is to reuse yeast, it is usually impossible to reuse immediately after harvest unless you want to make more beer than required. Cold storage of yeast in an anaerobic environment, for example in a bottle with an airlock, should keep the yeast in good condition for about two weeks. Anything longer than this will certainly begin to show obvious signs of cell death. In fact if yeast is stored for more than about seven days, cell death is easily measured using lab methods, but a two-week storage will still allow you to reuse the yeast for brewing.

The reason the yeast die is that yeast require nutrients to live. Without them the yeast essentially begin to starve. Many brewers believe that yeast cells go dormant during storage and are resistant to starvation. If the yeast are truly dormant this is true, but yeast are not dormant when simply placed in the refrigerator. Although not dormant, the yeast are in a slowed metabolic state, kind of like a warm-water fish in really cold water. This decreased metabolic state merely prolongs the inevitable — autolysis.

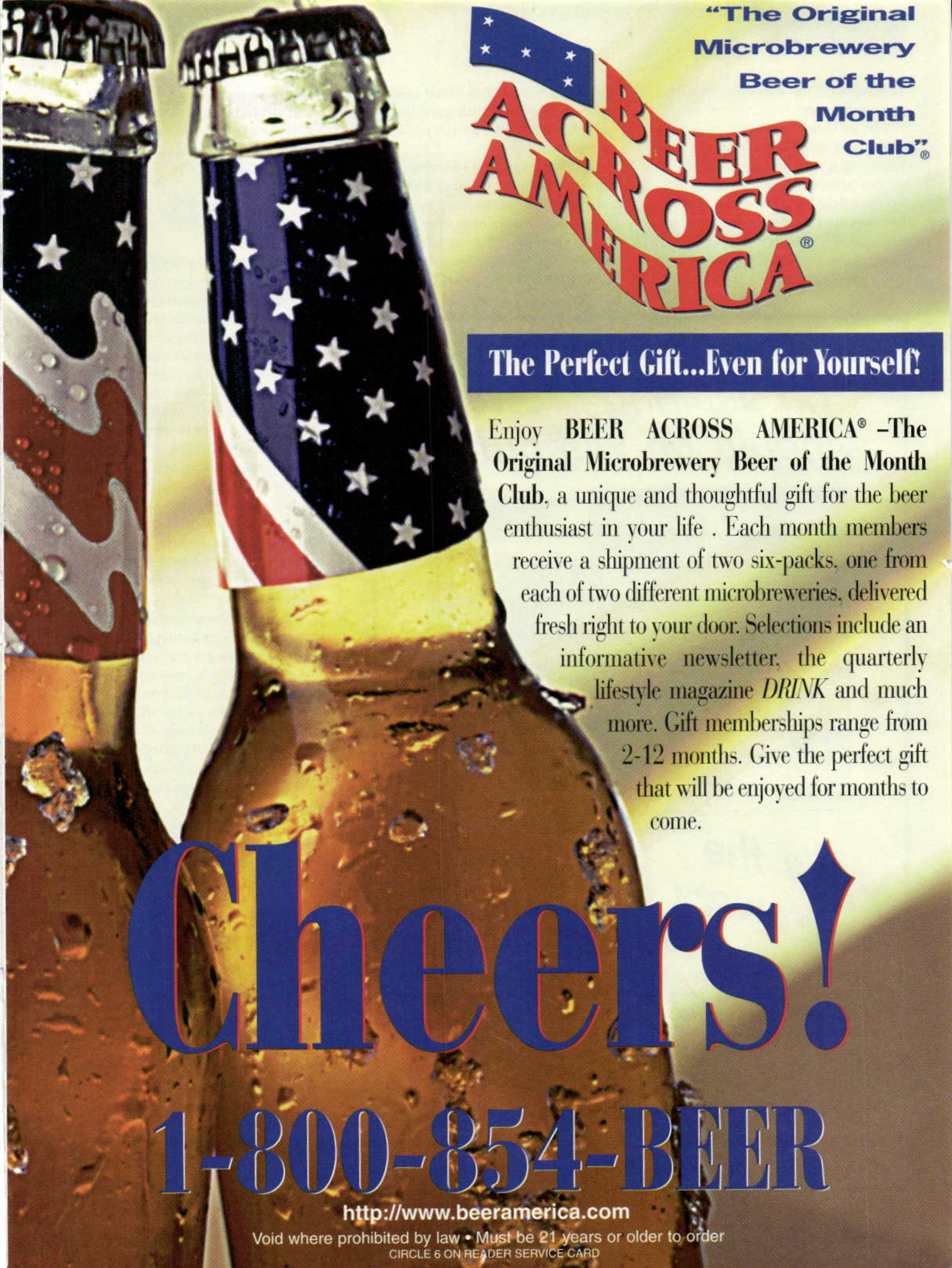
Autolysis, or self lysis (breakdown), is caused by cellular enzymes used by the yeast cell during normal metabolism acting on the yeast cell itself. These enzymes are normally managed by the yeast cell by containing them in special places within the cell, but as the cells get old and unhealthy these enzymes begin to leak from their respective storage areas within the cell and end up digesting the cell that created them.

Autolysis is accelerated by warm storage conditions and stressful environmental factors such as low pH and the presence of ethanol. This is why washing yeast prior to storage is beneficial. However, osmotic differences between the inside of the yeast cell and the storage environment can cause compounds to leave the inside of the yeast cell and go into the storage media. This is especially true if yeast are stored under water.

If you choose to wash yeast with water and store them in water, it is best to add between 0.5 percent and 1 percent of a compound known as Peptone. Peptone is a mixture of low-molecular-weight polypeptides (short amino-acid chains) added to water to prevent cells from shriveling up due to osmotic differences between the inside of the cell and the extracellular medium. Peptone can be purchased from any microbiological supply house.

The main problem with using autolyzed yeast cultures for repitching is that they have low viability, which means they do nothing in the pursuit of making beer. The only thing autolyzed yeast cells do to your beer is make it taste yeasty and, perhaps, carry with them bacterial cells that grow very well in the presence of decaying yeast.

Your next question regarding how many times can yeast be repitched before mutating is very difficult to answer because it depends on the yeast strain, the yeast storage conditions, the nature of the wort (gravity, amino acid content, aeration), and how you go about harvesting the yeast. For these reasons commercial breweries



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all have different experiences with yeast mutation.

Many lager breweries only repitch their yeast for five generations before replacing it because some lager strains are very prone to mutation. On the other hand, traditional ale brewers that harvest their yeast from the tops of fermenters have been using the same strain for more than 100 years without ever reculturing. These brewers are in effect reselecting only the yeast with good brewing qualities each time by the nature of top harvesting.

The only advice I can give is to carefully monitor fermentation rate, attenuation of fermentation, yeast flocculation, and flavor over time. If any of these parameters begins to significantly change from one fermentation to the next, you are likely witnessing the effects of mutation.

I strongly suggest reusing yeast for many reasons. However, when re-pitching it is very important to be careful. Cheers!

Mr. Wizard's Tip

While recently attending the National Craft-brewers Conference in Seattle, the Wiz spotted some pretty exciting raw materials worth seeking by microbrewers and homebrewers alike. Among these are malts that have been available to European brewers for a long time — more than 100 years — but only recently available in North America. One malt in particular was the floor-malted Maris Otter displayed by Crisp Malting of England. Although Crisp is not the only British maltster producing floor-malted Maris Otter, its malt can be found in the United States. The malt has an amazingly tender texture and wonderful biscuity, nutty and, er, malty flavor. Definitely worth tracking down.

Another interesting and exciting raw material was a monstrously high-alpha hop grown in America. The new variety Symphony ranges from 16 percent to 22 percent alpha acid. Break open a cone of this variety and feel the sticky humulones dripping from the hop lupulin glands. These new varieties not only have tons of bittering acids but also have interesting aromas.

The take-home message from the conference is: Keep an eye out for new products coming on the market from malt and hop suppliers. ■

Mr. Wizard's Address

Do you have a question for Mr. Wizard? Write to him c/o *Brew Your Own*, 216 F St., #160, Davis, CA 95616. Or send e-mail to wiz@byo.com.

Mr. Wizard, BYO's resident expert, is a leading authority in homebrewing whose identity, like the identity of all superheroes, must be kept confidential.

The Art of Dry Hopping

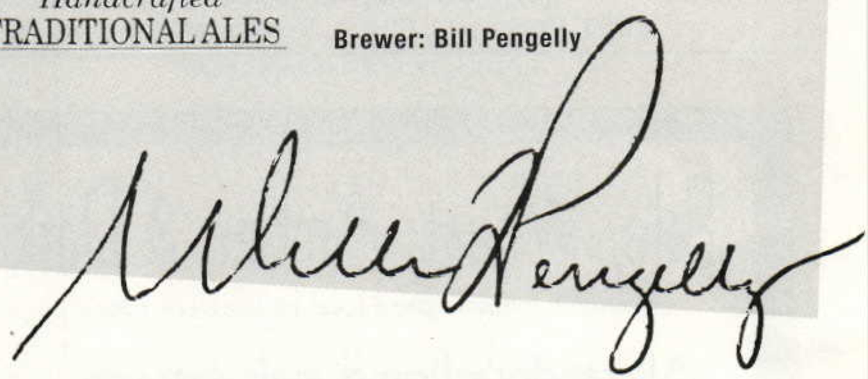
by Suzanne Berens

Deschutes Brewery

Handcrafted
TRADITIONAL ALES

"It's all empirical experience. You've got to actually play with it and do it to understand dry hopping."

Brewer: Bill Pengelly



Brewer: Bill Pengelly
Brewery: Deschutes Brewery, Bend, Ore.
Years of experience: 3.5 years
Education: Diploma from Siebel Institute in Chicago, PhD in biology from Princeton University
House Beers: Bachelor Bitter, Jubelale, Mirror Pond Pale Ale, Obsidian Stout, Cascade Golden Ale, High Desert Mild, Black Butte Porter, Bond Street Brown

The first rule about dry hopping is avoid contamination. Here at Deschutes Brewery we use acid to sanitize the bags that hold hops and the strings that tie them. But anything safe that can get into the beer and not give it an off flavor would be okay to use. You can clean the bags with bleach, but avoid sanitizing them with bleach because the bag or string would be soaked in it, and you don't want bleach in the beer. You could also sanitize by boiling. We use sanitized rubber gloves, like surgeon's gloves, when harvesting the hops and filling bags. It helps to avoid putting your hands on the hops and the bag.

Next you want to decide what hops to use. We use whole hops exclusively. They're best for dry hopping because you can get them out of the beer. Pellets will leave fine particles in the beer and carry over into maybe more intense hop character than you wanted until the beer can clarify and settle.

If you are a homebrewer using pellets in the boil, you would still buy whole hops for dry hopping. Trying to contain fine particles of pellets is difficult because they will escape the bags. If you do use pellets, make sure to get a finer grade of hop bag. You might be able to dry hop with pellets in a secondary fermenter and rack off into a keg or bottle.

Hop teas do not work well for dry hopping because what you want is the aroma, a soluble compound, and that's what boils off in your kettle. The whole point of dry hopping is to capture things that would boil off very easily by adding whole hops to cooled beer either in conditioning or in the final keg.

Find out what hops you like and what quantity you need to use. It all depends on the hop and how intense its aroma is. You might be more careful with some high-oil hops that are more intense than others. They would include Cascade, Centennial, Chinook, and Columbus. Some of the more noble hops like Saaz, Tettnanger, Hallertauer, and Kent Goldings are more mild and you can go heavier with them. You really just need to dry hop to taste. You can't calculate the flavor very well.

If a homebrewer does secondary fermentation, hops could easily be added to the secondary fermenter. You don't want them in primary fermentation. One reason is you don't want to mess with the yeast. Another is that you're degassing so much carbon dioxide that you're actually scrubbing away the volatile compound and being less effective. So do it in the secondary fermenter or in the (final) container. If brewers are bottling beer obviously

The Tips

- Sanitize the hop bag and string with a sanitizer that would be safe in beer.
- Avoid using hop pellets. They are difficult to extract from the beer.
- Use high-oil hops cautiously. Hops with less intensity can be used more liberally.
- Add whole hops to secondary and avoid hop teas, which tend to deplete aroma.

the secondary would be the way to do it. If you're kegging, then you could dry hop in the keg.

The optimum time to add hops depends on the brewer. It's good to dry hop a week or two before bottling or kegging. In the keg it will be on the dry hops the whole time. We have to keep on a schedule for production. A week is all we can do unless we use a cask. Hops go out to the account where the beer is served, but it's on the dry hops the whole time.

For our bottle products we do it in bright beer tanks because we don't do a secondary fermentation with our unitank system. We have to dry hop in bright beer tanks after we transfer the finished beer from fermenters and we only have a week on the dry hops.

The beers we dry hop are Bachelor Bitter, Jubelale, and Mirror Pond Pale Ale. We dry hop with Kent Goldings for the Bachelor Bitter and Jubelale and Cascade in the Mirror Pond Ale.

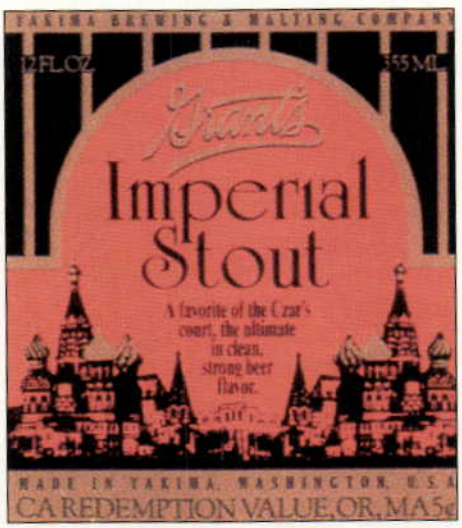
Our Golden Ale is a fairly low-gravity beer that has a lot of hops in it already, so it's a bit more delicate. We didn't want to add more hops to it. We do dry hop our porter with Tettnanger when we cask, but normally we don't dry hop it because the porter tends to be fairly low in hops and more pronounced in malt, whereas the other beers that we like to dry hop tend to be hoppier beers: pale ale, bitter, and the Julelale, which is like a strong ale, which can take a lot more hops. We will dry hop stout in the cask with Northern Brewer, but not in normal production. ■

Brewing the Other Stouts

by Jeff Frane

The Irish seem to have a lock on stouts, at least in the popular mind. Guinness, for sure, along with Murphy's and Beamish. Dry stout, the prevalent Irish style, which may be the original variation on porter, is not the only approach. Across the Irish Channel, and in some far-flung locations, stout is different.

Nothing is quite as different as sweet stout, England's dark answer to the milkshake. Mackeson, the acknowledged classic of the style, appeared early in this century and appears to remain unchanged. Unlike Irish stouts, which are brewed to attenuate thoroughly and finish very dry, Mackeson aims for a lush, rich finish and a high terminal gravity. The brewery achieves this by adding lactose (milk sugar) in the kettle. Unlike the sugars from malt (primarily maltose), cane (sucrose), or corn (dextrose), lactose is unfermentable by ordinary yeast and remains in the finished beer.



Mackeson apparently brews two versions of its stout, with the export market getting the best of the deal. The export beer is brewed to an original gravity of about 1.059; the home version's range is more moderate, about 1.042. Michael Jackson reports on a milk stout similar to the latter profile brewed on the island of Malta by Farsons.

Beers such as Mackeson and Farsons are variously known as sweet stouts, milk stouts, and cream stouts. The finish is very sweet indeed because of the residual sugar. Mackeson especially retains a great deal of mouthfeel and body because it is not filtered.

Yet another approach to a rich finish is to add proteins, usually by adding flaked oats to the grist. Jackson states that oats were originally added for perceived nutritional value, but I assume that economics played a role. Oats are more abundant and cheaper than malted barley, and the mechanics of using flaked grains are much simpler than Jackson seems to realize.

Oatmeal stouts had disappeared until Samuel Smith's Old Brewery revived the style in 1980 under the urging of Seattle importer Charles Finkel of Merchant du Vin. Other English brewers, including Young and Co.'s Brewery PLC of London, have joined in. Oatmeal stout seems to have a special panache among consumers (perhaps it's that "nutritional" thing again), and a fair number of American brewpubs and microbreweries brew the style.

A small addition of oats to the grist is not enough to create a noticeable effect, although it does allow a brewer to call the beer an oatmeal stout. At about 10 percent of the total grist, one would expect to see a significant change in the beer's character.

Flaked oats and, for that matter, flaked barley contribute to a rich mouthfeel and a thick, creamy head. Balanced with the burnt edge of roasted malt and the bitterness of hops, stouts like these are luscious, creamy counterparts to the very dry Irish style.

Throughout the 19th century some English breweries developed a large export industry, sending their beer down to the sea in ships. Much of the trade was on the Baltic in areas then part of the Russian Empire, now the free nations of Finland, Latvia, Lithuania, and Estonia. For some reason (those long, cold nights?) the Baltic customers demanded stout, and they wanted it rich, dark, and very strong.

Beers of this style became known as imperial stouts (because they were shipped to the Russian Empire). The undisputed classic, Courage's Imperial Russian Stout, still reigns today. It's brewed to an eye-popping 1.102 OG, with an alcohol content hovering around 10 percent by volume. Very high gravity beers such as this, especially those with a very high malt fraction, develop a profound fruitiness during fermentation. Courage's beer is brewed from pilsner, pale ale, amber, and black malts, with an addition of invert sugar in the kettle.

Survivals and revivals of the style appear in the former British market, the Baltic region, where they are known as porters. Although not brewed to the monster level of Courage, they are far stronger than the porters of the West. Finland's Koff Porter, for example, begins at 1.068 and is properly top fermented.

Back in England we find another revival, this one of imperial stouts. Samuel Smith introduced its version during the 1980s, again in response to a demand from the American market. It is a delicious beer, brewed with pale ale and caramel malts, roasted barley, and kettle sugar, to 1.072.

Yakima's Bert Grant introduced the Pacific Northwest to the style in the early 1980s. After a request from Courage Ltd., he dropped "Russian" from the name (now Grant's Imperial Stout) and the OG dropped from 1.080 to 1.070, still quite a respectable brew. It remains one of the brewery's finest beers (especially on draft) and a real treat on a cool evening. Grant spent years in the hop business and retains a real affection for them. One of his beer's charms is that the bitterness units match the gravity (70!). Definitely not a wimpy beer.

These "other" stouts must be

Midnight Molasses Lithuanian Imperial Stout

(5 gallons, extract with specialty grains)
Courtesy of Al Korzonas

Al Korzonas, an experienced homebrewer from Illinois, brewed this late at night (and had to run out at midnight for the molasses — hence the name). He emphasizes the need for a huge starter for this beer. The starter was allowed to ferment out entirely before brewing so that all the yeast had flocculated to the bottom. The spent wort was decanted off and a pint of fresh wort added the day before brewing.

This allowed him to build a huge supply of yeast and get the yeast into high kraeusen at pitching time (with the fresh wort). Yet it didn't force him to add the gallon of starter wort to his beer. He cautions that this beer (and all this yeast) requires an enormous amount of head space in the fermenter or a blow-off hose feeding into a very large container. It also sounds as though the beer should always be consumed while you're sitting down.

Ingredients:

- 6.6 lbs. Northwestern Gold extract syrup
- 3.3 lbs. Northwestern Amber extract syrup
- 3.3 lbs. Northwestern Dark extract syrup
- 1 lb. cara-Munich malt
- 0.5 lb. Special B malt
- 0.5 lb. roasted malt
- 0.5 lb. chocolate malt
- 0.5 lb. roasted barley
- 1 cup Grandma's Robust Flavor Molasses (at end of boil)
- 4.25 oz. Nugget hops (12% alpha acid), for 60 min.
- 2 oz. Northern Brewer hops (7% alpha acid), for 30 min.
- 1 oz East Kent Goldings (5.2% alpha acid), for 15 min.
- 2 tsp. calcium carbonate in boil
- 1 gal. starter of Wyeast 1028 yeast (see note)
- 2/3 cup priming sugar

Step-By-Step:

Steep milled specialty grains in 2 gals. 155° F water for 30 minutes using a grain bag. After steeping rinse grains with 1 gal. water (165° to 175° F). Add extracts and calcium carbonate, adjust total wort volume to 6 gals., and bring to a boil. Add Nugget hops at beginning of boil. Boil 30 minutes and add Northern Brewer hops. Boil 15 minutes more and add East Kent Goldings hops. Continue boiling for 15 minutes longer, turn off heat, and add molasses. Cool wort to 70° F. Add yeast slurry.

Ferment completely at 70° F, rack to secondary, and hold for seven days before bottling. Prime with sugar and condition for at least four weeks at room temperature before sampling. Once beer is carbonated, move bottles to a cool storage area and sample periodically until beer is at peak flavor. This may take upwards of four months.

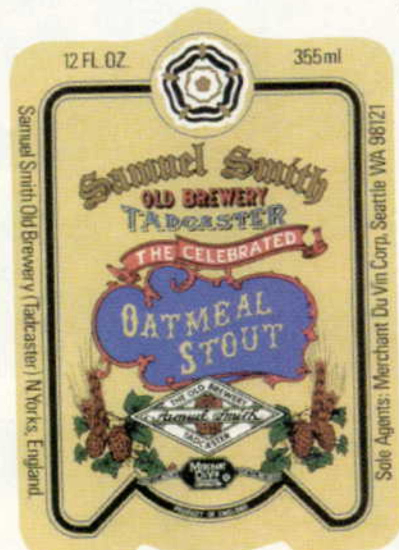
OG = 1.115
TG = 1.038

distinguished from the dry, Irish style. Except for the bottled export version, Irish stouts are of moderate gravity (around 1.040 to 1.045), with significant roastiness and a decidedly dry finish, although the use of raw barley and a nitrogen dispense add an element of creaminess.

Sweet (milk) stouts are a similar color (very dark brown to black) but otherwise very different. Bittering levels are way down, to better allow the distinct sweetness of residual sugars to dominate. Low-alpha-acid British hops, such as Fuggle and Goldings, are a good choice. The flavor of roasted malts is likewise subdued. Alcohol content is medium to moderately high. The beers are brewed from ale malts (pale and mild), caramel malts (very dark), and

chocolate malt (not black). Along with the lactose, brewer's caramel is added for flavor and color.

Oatmeal stouts are less sweet, although full of mouthfeel and body. Bitterness and roasted flavor is more pronounced than in cream stouts but not as apparent as in dry stouts. Oatmeal stouts are usually rich, silky, and satiating. Original gravities are in the "normal," moderate range (about 1.045). Other than the oats, the grists can be built from a wide range of malts (pale ale, pilsner, caramel) and with a significant portion of chocolate or black malt, or roasted barley. Any of a wide range of hops can be used.



Imperial stouts are big — no, huge — beers, very dark, very rich, and very strong. Not the king of beers but the emperor. Minimum gravity around 1.070, but the sky (or the yeast's tolerance for alcohol) is the limit. In many ways these beers are closer to barleywines than to the other stouts, estery, perhaps winey: a perfect breakfast treat, in other words.

It's difficult to brew all-malt beers to this gravity, and sugar (or honey, in Grant's Imperial Stout) is entirely appropriate, a good opportunity to experiment with dark, raw sugars or perhaps molasses. Likewise, a good opportunity for lots of good ale malt and dark, sweet caramel malts. And an opportunity to use those super-alpha hops. The British demonstrate a preference for Target (about 10 percent to 12.5 percent alpha acid), but they have some new varieties like Admiral (11.5 to 14.5 percent!) that sound like the perfect choice. American varieties such as Nugget and Chinook are worth experimenting with as well.

Yeast choices for the "other" stouts should be fairly simple; almost any good, vigorous ale strain should work nicely. The Irish strains tend to have a noticeable diacetyl (buttery) contribution and ought to work as well as the dry in the sweet versions, but any number of other strains should be fine. Imperial stouts do not require any special ale strain, but the yeast must be alcohol tolerant (anything that could be used for a barleywine will work) and you must have a lot of it. As with barleywines, the best strategy seems to be to brew a beer of normal gravity as a starter and either pitch a quart of freshly fermenting beer into the wort or recover all the yeast from the ale and pitch that. In either case the wort must be thoroughly aerated; these yeast will need all the help they can get. In spite of the claims of some homebrewers, wine yeasts are not necessary for high-gravity beers, if care is taken.

Any of the stouts can be brewed successfully as extract/grain beers or all-grain. An all-grain imperial stout will require a lot of grain, but the original gravity can be boosted through the use of sugar in the kettle. As with barleywines, one of the most successful techniques is to eliminate the sparge and to simply boil all the sweet wort drawn out of the mash/lauter tun. The remaining sugars can be extracted by sparging and used for "small" beer, and might well make a decent dry or sweet stout of very moderate alcohol content. ■

Oatmeal Stout

(5 gallons, all-grain)

Ingredients:

- 7 lbs. pale or mild ale malt
- 0.5 lb. roasted barley
- 0.5 lb. caramel malt, 40° to 60° Lovibond
- 1 lb. rolled oats
- 1.25 oz. Columbus hops (15% alpha acid), for 75 min.
- ale yeast

Step-By-Step:

Mash grains in 3.5 gals. of soft- to medium-hard water at 152° F for 90 minutes (iodine tests are tough with beer this dark, so allow the full time period). Sparge to 6 gals. and boil for 90 minutes. Add the hops after 15 minutes. Cool, aerate thoroughly, and pitch a 1 to 2 qts. starter of vigorous ale yeast. Follow normal fermentation procedures (I prefer open fermenters for the primary), rack to secondary when kraeusen falls (about four to five days), and allow beer to finish out (about seven to 10 more days). Follow your normal bottling or kegging procedure.

OG = 1.052
FG = 1.012

ADD BODY TO YOUR BEER

by Ron Bach

It is time to try your first bottle of that (hopefully) great beer you have just brewed. You pop the cap, nice hiss, good carbonation. You pour your beer and admire its creamy head, good color, and sparkling clarity. The aroma is a fragrant bouquet with some fruity esters and a nice balance of malt and hops. Your first taste reveals some maltiness and then notes of hop spiciness. On your second taste you turn your attention to the body, or mouth-feel. It should be firm and smooth — but wait, something is wrong. The beer is thin and somewhat watery. Not to worry.

A variety of steps cause the body to be different than intended. A good understanding of the techniques and processes that influence body will aid the homebrewer in making that special beer.

A Definition

Body is the sensation of palate fullness, the viscosity and feel of beer in the mouth. It is a characteristic of beer that reflects its ending density and refers to the mouth-filling and thickness properties that a given sample contains.

Protein, unfermentable sugars

RICK HUDSON

(dextrins), beta-glucans, carbon dioxide and, sometimes as in Guinness, nitrogen, nuetral alcohols, and foam, which really depends on most of these factors, make up beer's body. The terms mouthfeel and body may be interchangeable.

Mouthfeel qualities are distinctly different from flavor. This concept is often misunderstood. The Beer Judge Certification Program (BJCP) and the American Homebrewers Association (AHA) on their beer competition score sheet have five major categories that include appearance, bouquet/aroma, flavor, body, and drinkability. Body accounts for five points out of a possible 50 points, or 10 percent of the score.

Body is rated as thin (light) to full (heavy), with many other descriptors applying. These include sweet, neutral, dry, bland, vinous, firm, smooth, rough, watery, and proper or improper for the style.

There are two other characteristics often associated with mouthfeel. Astringency is a dry, puckering sensation that is more mouthfeel than flavor. Although "alcoholic" is sometimes considered a taste, its warming sensation caused by ethanol and higher alcohols is also considered a characteristic of body.

The description of a beer as thin or full bodied can be appropriate for certain styles of beer. American lagers are classified as light bodied, while at the other end of the spectrum are full-bodied beers such as bock beers and imperial stouts. Barleywines are classified as very full bodied.

The Significance of Protein

Of the prominent factors contributing to body in beer, protein is considered most significant.

Protein is an enormously complex organic compound containing nitrogen derived from amino acids. In the brewing process it is an essential compound whose role is often misunderstood for good reason.

Almost all of the protein encountered in brewing comes from grain. The vast majority of nitrogen is supplied by the protein, which averages 16 percent nitrogen.
A strong, healthy fermentation must have sufficient nitrogen derived from protein.

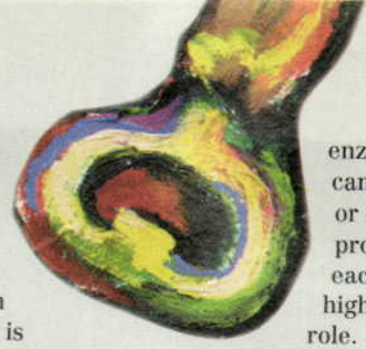
Proteins are similar to carbohydrates in that they are very long chains of complex molecules that are elementary building blocks linked together in specific ways. Complex proteins are formed by long chains of amino acids linked together by peptide bonds.

Protein in the proper form and amounts contributes to mouthfeel or body of beer, promotes head retention, and provides essential nutrients for yeast to promote strong, healthy fermentation. The wrong amount of protein contributes to myriad problems including turbidity, flavor instability, poor head retention, and sluggish or stuck fermentation.

The majority of protein molecules in raw, unmalted grain are extremely large and must be broken down. This starts with the malting process, in which whole, unmalted barley is germinated to a certain degree and then dried to make malted barley. The most significant action that occurs is the development of enzymes that act directly to degrade or modify the complex chains of nitrogen-based proteins into smaller chains of amino acids correctly termed polypeptides, not proteins, and into single amino acids. Also, small amounts of dextrins and fermentable sugars are developed and some insoluble starch is made soluble.

Long chains of high-molecular-weight protein are undesirable, and at least 50 percent of these long chains should be broken down into medium and small chains or removed to enhance body and heighten flavor stability, head retention, attenuation, and clarity and to provide a strong, healthy fermentation.

Enzymes are perhaps the most important class of protein in the brewing process. At least eight



enzymes in malt can break down or degrade proteins, but each plays a highly specific role.

Enzymes Do What?

The enzymes most critical to contributing body to beer are proteases, or proteolytic enzymes, which break down proteins into polypeptides and amino acids, and beta-glucanases

Tips to Build Beer Body

1. Select malt that is not overmodified. In general lager malts and pale domestic malts have more body builders than traditional ale malts used in Britain.

2. Use a limited portion of raw materials with a high proportion of body-building components. These components include: dextrin malt, crystal malt, flaked barley, and flaked oats.

3. Use higher saccharification temperatures to limit the fermentability of the wort and produce more dextrins.

4. Select a yeast strain that has a relatively low degree of attenuation. This information is provided by most yeast suppliers in their technical data sheets.

5. Avoid excessive use of finings or using a very tight filtration unit. Both of these practices can strip body from beer.

6. Don't expect rich, full mouthfeel from light beers with low original gravities. If you really want full mouthfeel, make higher-gravity beers; they have a higher concentration of body building compounds.

7. Pour your beer in such a manner as to produce a nice foam head. Beer foam, like the foam on a cappuccino, adds mouthfeel. Similarly, using mixed gas dispense or hand pumps to serve beer from kegs will produce richer, creamier foams compared with conventionally dispensed beers.

which reduce the size of beta-glucans into smaller and less viscous, hence less mouthfeel, beta-glucan molecules. The bulk of these enzymatic changes occur during malting.

During germination the barley seed synthesizes these enzymes, along with many others such as amylases, to allow the seed to grow. The barley seed grows by dissolving large organic molecules found in the barley's starch endosperm to give the growing seed sugar. The endosperm is a complex structure of starch granules, sought after by brewers, embedded in a protein matrix and encased by cell walls made of beta-glucans.

Beta-glucanases dissolve the endosperm cell walls and allow the proteases to begin breaking down the matrix surrounding starch granules, which in turn allows the amylases to convert barley starch into sugars needed by the growing embryo. The maltster and brewer want the cell walls and protein matrix to be degraded but want to retain as much starch as possible. When the embryo uses sugars for energy, carbon dioxide and water are formed that are lost from the malt. This is called malting loss and must be controlled by the maltster.

Malts with low losses during malting are usually undermodified, which means they retain a lot of barley-like qualities, such as intact cell walls and undegraded proteins. Beers made from these malts typically have good mouthfeel qualities. Traditional lager malts tend to be less well modified than traditional ale malts.

Malts with higher losses are usually overmodified and contain few intact cell walls and a high proportion of small polypeptide fragments. Beers made from these malts may suffer from poor mouthfeel qualities, especially if the malts are excessively overmodified.

The conventional wisdom concerning this whole process of protein breakdown was that a lot of it occurred in malting and that more occurred in mashing during the

"protein rest." The idea held that undermodified malts require a protein rest to increase the levels of wort amino acids and to reduce the size of the protein that, if left undegraded, would cause problems in lautering. The problem with this idea is that almost all malt proteases are destroyed during kilning.

This view is no longer held by many brewing scientists, however. The research conducted by a group led by brewing science professor Michael Lewis, Ph.D, at the University of California, Davis, in the 1980s indicates that the protein rest merely dissolves protein, which is then later precipitated at higher temperatures but does not have a proteolytic component. This idea has more recently been confirmed by research groups at John Labatt Ltd. and Miller Brewing Co.

Some beta-glucanases that survive kilning can further reduce beta-glucan size, and hence wort viscosity, at temperatures between 100° and 130° F. The activity of these enzymes tends to reduce mouthfeel but reduces the problems in lautering associated with undermodified malts.

Starch-Degrading Enzymes

Other enzymes that the homebrewer can significantly control are alpha- and beta-amylase, which both degrade starch. These enzymes convert the long, complex chains of starch molecules into dextrins and fermentable sugars. Dextrins give beer fuller body and aid in head retention.

Saccharification is the process of converting large, complex molecules of starch into fermentable sugars such as glucose, maltose, and maltotriose, and larger, unfermentable dextrin chains (dextrins have four or more glucose molecules in their chain). Saccharification is due to the action of alpha-amylase and beta-amylase. Alpha-amylase randomly breaks the starch into smaller pieces. Beta-amylase attacks the non-reducing end of starch (of which there are very many) and the products of alpha-amylase to yield maltose.

Long chains of the simple sugar glucose make up starch, which is not fermentable in these attached chains. Double glucose molecules comprise very fermentable maltose, and four or more glucose molecules resulting from the incomplete breakdown of starch are unfermentable sugars that are tasteless and add body or mouthfeel to beer.

Because starch contains many branch points in its structure and beta-amylase cannot attack these branches, the random action of alpha-amylase enables beta-amylase to be more effective at producing maltose. Beta-amylase is most active between 140° and 149° F and alpha-amylase is most active around 158° F. Thus, lower temperatures and/or slower temperature increases from say 140° F to 158° F will result in more maltose; these worts are very fermentable and may suffer from poor mouthfeel. Higher temperatures will tend to produce worts with a higher proportion of dextrins. This means less alcohol but more of the compounds associated with body.

The extract brewer needs to pay attention to the type of extract used. Some extracts are more fermentable than others. Two extracts that have lower fermentability resulting in fuller-bodied beers are Laaglander and John Bull of England. Two extracts with relatively high fermentability are Alexander's light malt extract and Munton's light malt extract. Ask your local homebrew supply shop about malt's fermentability, and keep detailed notes on the brands with which you have experimented.

Body Builders

There are many raw materials that have high proportions of body-building compounds that are commonly used to increase the mouthfeel of beer. These include dextrin malt, malto dextrin, crystal malt, flaked barley, and flaked oats.

Dextrin malt. Dextrin malt is made from malted barley and is a type of crystal malt. Also known as cara-pils or cara-crystal, dextrin malt contributes body to beer, aids in foam retention and beer stability, and gives the beer additional smoothness and sometimes a sense of sweetness. All this is accomplished without affecting the color or flavor of the beer.

Dextrin malt is stewed at higher temperatures than crystal malt, resulting in the creation of a larger proportion of dextrins. Then it is kilned at very low temperatures to avoid darkening, rendering it tasteless and relatively colorless. Therefore, it may be used on both pale and dark beers. Use dextrin malts for 5 percent to 20 percent of total grist to achieve full advantage for light-colored beer and 2 percent to 10 percent of total grist in dark beers. Because dextrin malt has been enzymatically degraded during processing, it does not need to be mashed with enzymatic grains and can be used in partial grain mashes.

For the extract brewer dextrin powder or malto-dextrin adds another dimension to brewing. Most malt extracts are designed for a standard ratio of fermentability. The use of dextrin powder allows a fuller brew. Dextrin powder is added to the boiling wort. Check the dextrin content of the powder to see if any portion consists of fermentable sugar. If so, adjust accordingly.

Crystal malt. Crystal malt, also know as caramel malt, like dextrin malt will add body and head retention to beer. Unlike dextrin malt, it will also add sweetness and enrich the color of beer. It comes in a variety of colors from light to dark. It can also be used in partial grain mashes.

Lactose. Lactose is unfermentable milk sugar, which may be used to increase body and mouthfeel, especially in sweet stouts. It may be added directly to the boil.

Flaked barley and oats. Unmalted, flaked grains, especially barley and oats, are rich in large beta-glucan gums from undegraded cell walls and contain a lot of undegraded proteins. Both classes of compounds are associated with mouthfeel, especially undegraded beta-glucans. In fact much of the protein contributed by these products never makes it into the wort because it is lost during mashing and boiling. This is not the same with polypeptides from malted grains. The beta-glucans, however, do survive and give wort and beer added viscosity. It is for this reason that lautering and filtration can be significantly affected by unmalted and undermodified grains. In practice these products should not exceed 15 percent of the total grist bill.

Notable examples of beers that use flaked grains for mouthfeel purposes are Guinness Stout, which uses flaked barley, and Samuel Smith's and Young's oatmeal stouts, obviously using oatmeal.

Finishing Practices

Some features of fermentation and finishing (maturation and clarification) can have a pronounced effect on mouthfeel because they can alter the amount of body-building compounds found in beer. The selection of yeast and the use of clarifying agents and filtration methods are important for this reason.

Attenuation. Another factor that can play a role in body and mouthfeel is attenuation. A high-attenuating yeast will ferment out, further providing a lower final gravity with a thinner-tasting beer. Such a beer is usually drier and less malty. The strain of yeast used is important, and with some styles of beer, the body will need to be compensated for in brewing to offset high-attenuating yeast. Remember, the medium-length proteins can be increased or the dextrin in the beer can be enhanced to provide for a smoother, more full-bodied beer.

Clarifying agents. There are several other factors that the homebrewer needs to be aware of that affect body. Haze can be a problem in brewing, and one of the causes of haze is large protein molecules in the finished beer. Clarifying agents such as Irish moss, gelatin, isinglass, and Polyclar help bond haze molecules together and drop them out of suspension. Care must be taken not to overuse clarifying agents, because they can remove not only the large haze-producing protein molecules but also the medium-chained proteins that promote body and mouthfeel.

Filtering. Filtering beer to reduce or eliminate chill haze can also strip out body, flavor, and head retention. Do not use a micron filter that is too fine. The heavier, more full-bodied beers can be affected most by filtering the beer.

> ◆
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> **Some features of fermentation and finishing can have a pronounced effect on mouthfeel.**
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> ◆

Ron Bach is an award-winning homebrewer, certified beer judge, competition organizer, and president of the Central Florida Homebrewers club.

Re

Joel Baumwart

Lubbock Homebrew Supply
Lubbock, Texas

"The Ultimate Porter was created while looking for the perfect porter. I believe I have found it. I have brewed it four times now, and it is the perfect blend of hop aroma and dark bitterness."

Ultimate Porter

(5 gallons, extract/specialty grains)

Ingredients:

- 6 oz. chocolate malt

Extract
ecipes

20 homebrew retailers share their favorite extract recipes.

- 2 oz. black patent malt
- 0.5 lb. crystal malt, 120° Lovibond
- 0.5 lb. wheat malt
- 0.5 lb. victory malt
- 7 lbs. Alexander's pale malt extract
- 1 oz. Chinook hops (13% alpha acid), for 60 min.
- 1 oz. Cascade hops (5.5% alpha acid), for 10 min.
- 1 oz. Strissal Spalt hops (4% alpha acid), for 2 min.
- 1/2 tsp. Irish moss, for 20 min.
- Wyeast 1084 Irish Ale yeast

Step by Step:

Steep grains at 150° F for 20 minutes in 3 gals. of water. Remove grains and bring the liquid to a boil. Add extract and Chinook hops and bring back to a boil. Boil 40 minutes and add Irish moss. Boil 10 minutes more and add the Cascade hops. Boil 8 more minutes and add the Strissal Spalt. Total boil is 60 minutes. Cool the wort. Place in fermenter and top off to 5 gals. Pitch yeast when cool enough. After two weeks prime with corn sugar and bottle.

Lee Kraemer
Michael Vitez

**L.L. Kraemer Co.
Bloomington, Minn.**

"This recipe makes an excellent special bitter, full-flavored, full-bodied beer that is sure to please. It has won several medals in local competitions. Edme dry malt syrup has a great flavor."

Frosty Toad British Ale
(5 gallons, extract/specialty grains)

Ingredients:

- 1 lb. Hugh Baird English crystal malt, 40° Lovibond
- 3.3 lbs. Edme dry malt syrup
- 3 lbs. amber dry malt extract (domestic Northwestern)
- 2 oz. Cascade hop pellets (11% alpha acid), for 60 min.
- 0.5 oz. Fuggle hop pellets, for finish
- Liquid British ale yeast or Wyeast 1098
- 2 tbsp. gypsum
- 1 tsp. Irish moss, for 15 min.
- 3/4 cup dextrose or 1.25 cup dry malt extract for priming

Step by Step:

Add gypsum to cold water and heat to 170° F. Steep crushed crystal malt in straining bag for 15 minutes at 170° F. Remove bag, add malt extracts and Cascade hops, and bring to a boil for 45 minutes. Add Irish moss and boil 15 minutes more. Total boil is 60 min. Add Fuggle hops when heat is turned off.

Ron Thomas

Foothills Homebrew Supply
Siverton, Ore.

"This apricot ale won first place in the Oregon Homebrew Festival, second at the Oregon State Fair, and third at the Mill Creek Classic in 1996."

Apricot Ale
(5 gallons, extract)

Ingredients:
- 3 lbs. Briess wheat dry malt
- 2.2 lbs. Morgan's wheat malt extract
- 2 oz. Tettnanger loose hops (4.2% alpha acid), 1 oz. for 60 min., 1 oz. for 10 min.
- Munton's ale yeast
- 4 oz. Apricot extract
- 3/4 cup corn sugar for priming

Step by Step:

Add malt extracts to 6 gals. water and bring to boil. Add 1 oz. hops and boil 50 minutes. Add 1 oz. hops and boil for 10 minutes more. Total boil is 60 minutes. Cool. Pitch yeast and ferment at 65° to 70° F in glass. After one week transfer to carboy. Add apricot extract. Bottle after one to two weeks. Age six to eight weeks.

OG = 1.043
FG = 1.012

Larry Medearis

Bridgeview Beer and Wines
Oregon City, Ore.

"A sweet stout with a strong flavor and high alcohol content."

Medearis' Mad Stout
(5 gallons, extract/specialty grains)

Ingredients:
- 7.5 lbs. Hollander Dutch dark extract
- 1 lb. chocolate malt
- 1 lb. roasted barley
- 0.75 lb. black malt
- 0.5 lb. British crystal malt, 40° Lovibond
- 0.5 lb. dextrin malt
- 2 oz. Eroica hops (12.6% alpha acid), for 60 min.
- 1 oz. Kent Goldings hops (5% alpha acid), for 1 min.
- 6 tsp. gypsum
- 1 tsp. Irish moss
- Wyeast 1084 (Irish ale yeast)

Step by Step:

Grain must be steeped separately at 150° to 160° F for 25 to 30 minutes in 2 gals. water. Add extract and Eroica hops and boil for 60 minutes. Add Kent Goldings for last minute of boil. Remove from heat, cover, and let stand for 10 minutes before cooling the wort. Top off to 5 gals. and pitch yeast. Ferment and prime with corn sugar.

Jim McHale

Beer Unlimited
Malvern, Pa.

"This is a beer for true hop heads. It has won awards at several regional homebrew competitions."

India Pale Ale
(5 gallons, extract/specialty grains)

Ingredients:
- 2 cans Alexander's pale malt extract
- 0.5 lb. American crystal malt, 40° Lovibond
- 4 oz. Centennial hops, 1.5 oz. for 60 min., 0.5 oz. for 30 min., 1 oz. for 2 min., 1 oz. dry hop
- 1 tsp. Irish moss (optional)
- Wyeast 1056 American ale yeast
- 2 tbsp. gelatin finings (optional)
- 3/4 cup corn sugar for priming

Step by Step:

Steep grains in 1 gal. of 155° F water for 30 minutes. Remove grains and add 3 more gals. of water. Turn off heat and add extract. Return to boil. When boiling starts, add 1.5 oz. of hops. Boil 30 minutes. Add Irish moss (optional) and 0.5 oz. of hops and boil 30 minutes more. Add 1 oz. of hops during the last two minutes of boil. Total boil is 60 minutes. Pitch yeast when wort cools. Dry hop with final ounce of hops (add to primary fermenter two days before racking). Use gelatin (optional) in secondary fermenter and/or at bottling.

OG = 1.058
FG = 1.015

Raymond Ault

The Beverage Co.
Anderson, Calif.

"This is a beer for customers who have had little exposure to the heavier ales."

Lawnmower III
(5 gallons, extract/specialty grains)

Ingredients:
- 4 lbs. Alexander's pale malt extract
- 0.5 lb. flaked corn
- 2 lbs. white rice syrup
- 1.75 lbs. six-row barley (crushed)
- 1.5 oz. Cascade hops (5% alpha acid), 1 oz. for 60 min., 0.5 oz. at end of boil
- European lager yeast

Step by Step:

Steep grain and corn at 150° F for 30 minutes in 2 gals. of water. Remove the grain bag and add malt extract and rice syrup. Bring to a boil. Add 1 oz. hops when mixture begins to boil. Boil 60 minutes and then add aroma/finishing hops and remove from heat. Force cool. Place in fermenter. Bring up to 5 gals. with previously boiled and cooled water. Pitch yeast. Age six weeks at 60° F. Prime with corn sugar.

Gary & Elisa Wilder

Brew Your Own Brew
Tucson, Ariz.

"Very smooth with a light sweetness and 6.7 percent alcohol by volume."

Honey Steamer

(5 gallons, extract/specialty grains)

Ingredients:

- 6.5 lbs. light malt extract syrup
- 0.5 lb. crystal malt, 40° Lovibond
- 2.5 lbs. honey
- 1 oz. Bullion hops (8.1% alpha acid), for 25 min.
- 1 oz. Cluster hops (7.4% alpha acid), for 10 min.
- 1/3 oz. Irish moss
- Wyeast 2112 (California)

Step by Step:

Add crystal malt (in bag) to 2 gals. cold water. Slowly bring to 170° F. Remove grains, bring liquid to boil, and add extract and honey. Boil for 35 minutes, then add Bullion hops. Boil for 15 more minutes, and then add Cluster hops and Irish moss. Boil 10 minutes. Total boil is 60 minutes. Remove from heat and cool. Add water to make 5 gals. Pitch yeast. Prime with corn sugar.

Rob Bates

Reno Homebrewer
Reno, Nev.

"This beer is like the Sierra Nevada Celebration Ale, rich and malty with a refreshing, hoppy character."

Red Hawk Ale

(5 gallons, extract/specialty grains)

Ingredients:

- 6 lbs. amber malt extract
- 1 lb. crushed crystal malt
- 1 lb. light dry malt extract
- 2 oz. Willamette hops (5% alpha acid), for 60 min.
- 2 oz. Cascade hops (5.5% alpha acid), after boil
- Ale yeast
- 3/4 cup corn sugar for priming

Step by Step:

Heat 1 gal. of water to 155° F and steep crystal malt for 30 minutes. Remove grain and add 3 more gals. of water along with extracts. Bring to a boil and add Willamette hops. Stir until malt is completely dissolved. Continue boiling for one hour. Turn off heat. Add Cascade hops and let steep for 10 minutes. Strain wort into sterilized fermenter. Add sufficient sterilized water (water boiled for five minutes) to equal 5 gals. When at 90° F, pitch yeast.

Let beer ferment between 60° F and 70° F for at least two weeks or until you are sure the fermentation is complete. Then boil 1 cup water with corn sugar and add this solution to fermented beer for priming. Bottle and cap. Allow to sit at room temperature for a week. Wait at least another week and then open and enjoy!

Henry W. Jones IV

Cottage Brewing Supply
Rochester, N.Y.

"A good clone of Samuel Smith's Taddy Porter. Tastes like a good porter should."

Porter

(5 gallons, extract/specialty grains)

Ingredients:

- 1 can Edme Super Flavex unhopped dark syrup
- 1 lb. Munton's light dry malt extract
- 1.5 lbs. Munton's amber dry malt extract
- 0.5 lb. American crystal malt, 40° Lovibond
- 0.5 lb. English chocolate malt
- 0.25 lb. black patent malt
- 2 oz. Fuggle hops (8.8% alpha acid), for 60 min.
- 0.5 oz. Willamette hops (4% alpha acid), for 15 min.
- Wyeast 1098 (British ale)

Step by Step:

Add grains to 1.5 gals. water and steep at 155° F for 30 min. Remove grains, bring to a boil, and add extracts and Fuggle hops. Boil for 45 min. Add Willamette. Boil for 15 more minutes and add to fermenter. Pitch yeast when cooled to 70° F. Prime with corn sugar.

OG = 1.050
FG = 1.013

Kevin Norman

The Cellar Homebrew
Seattle, Wash.

"Full-bodied is an understatement for this dark stout. It is downright chewy. The oatmeal provides the unfermentable starches and beta-glucan gums that give this beer its remarkable mouthfeel, while the use of specialty grains gives it a distinctive roasted quality. Perfect for those winter evenings in front of the fireplace."

Quaker's Stout
(5 gallons, extract/specialty grains)

Ingredients:

- 6 lbs. Alexander's amber malt syrup
- 2 lbs. Munton's dark dry malt extract
- 0.75 lb. English crystal malt, 70° to 80° Lovibond
- 0.5 lb. chocolate malt
- 0.25 lb. black patent malt
- 0.5 lb. roasted barley
- 1 lb. rolled oats
- 1/2 stick of brewer's licorice
- 1 oz. Chinook hops (13% alpha acid), for 60 min.
- 2 oz. Willamette hops (5% alpha acid), 1 oz. for 60 min., 1 oz. for 3 min.
- Edme dry ale yeast or Wyeast 1084 (Irish Ale)

Step by Step:

Place specialty grains in strainer bag. Place rolled oats in separate strainer bag. Add to 2.5 gals. water in brewing kettle. At boil remove specialty grains but continue to boil rolled oats for about 10 minutes. Remove bag of rolled oats. Add malt extracts, brewer's licorice, and Chinook and 1 oz. of Willamette hops to the boiling water. Boil and stir for 60 minutes. During the last three minutes of the boil, add remaining Willamette hops. Prime with corn sugar.

OG = 1.070 to 1.075
FG = 1.018 to 1.022

Tom Graham

Winemaker's Pantry, Inc.
Pinellas Park, Fla.

"This is a really nice bitter ale that we have made 10 or so times. It is so good we're afraid to try variations of the recipe."

Tom's Creation
(5 gallons, extract/specialty grains)

Ingredients:

- 4 lbs. Alexander's amber malt extract
- 4 lbs. Alexander's pale malt extract
- 1 lb. Munich malt
- 2 oz. Northern Brewer hops (8% alpha acid), for 45 min.
- 1 tbsp. Crosby & Baker water crystals
- 1 oz. Perle or Northern Brewer hops (8% alpha acid), for 5 min.
- 2 packages Cooper's yeast
- 1 cup dextrose for priming

Step by Step:

Place 1 lb. of cracked Munich grain into a hop bag and put into 1.5 gals. of water. Bring water to 170° F. Turn off burner, but do not remove kettle from burner. Cover and steep for 10 to 15 minutes. Remove bag of grain and mix in malt extracts and water crystals. Bring to a boil for 10 to 15 minutes and add 2 oz. Norther Brewer hops. Boil for 45 to 50 minutes more. Add the 1 oz. Perle or Northern Brewer hops during the final five minutes of the boil. Remove from heat and cover for 10 minutes. Cool wort, transfer to primary fermenter, top up to 5 gals. if necessary. Rehydrate yeast and pitch.

After primary fermentation is complete, transfer to a five-gallon glass jug. Top up and add stopper and airlock. After two to three more weeks, transfer to priming container, prime, and bottle.

OG = 1.054
FG = 1.021

Will Holway
Ken Bustinski
Scott Law

Wind River Brewing
Eden Prairie, Minn.

"Unlike many India pale ales, which lack the strength of the original IPA recipes, ours measures up. Its malty richness and assertive hop punch are guaranteed to please."

Northern India Pale Ale
(5 gallons, extract/specialty grains)

Ingredients:

- 6 lbs. gold light malt extract
- 3.3 lbs. amber light malt extract
- 0.5 lb. crystal malt, 50° Lovibond
- 0.5 lb. toasted malt, 25° Lovibond
- 2 oz. Cascade hops (7% alpha acid), for 60 min.
- 1 oz. Willamette hops (4.8% alpha acid), for 5 min.
- 1 oz. East Kent Goldings hops (5.5% alpha acid), for 5 min.
- Wyeast 1098 (British ale)

Step by Step:

Heat 3.5 gals. of water to 170° F, pour grains into steeping bag and add to water for 15 minutes. Remove grains and add malt extract and 1 oz. of Cascade hops. When wort begins to boil, add another 1 oz. of Cascade hops. Boil 55 minutes and add Willamette and East Kent Goldings hops. Boil 5 more minutes. Total boil is 60 minutes. Cool wort and transfer to fermenter. Top off to 5 gals. Add yeast and ferment 10 to 14 days. Bottle or transfer to secondary when fermentation is complete. Prime with corn sugar. Drink and enjoy in moderation!

Step by Step:

Steep crushed crystal malt at 150° F in 2.5 gal. of water for 15 minutes. Remove grains and bring to a boil. Add malt, gypsum, and Northern Brewer hops. Boil for 55 minutes. Add East Kent Goldings hops and boil for five more minutes. Cool brewpot in cold water bath for 15 to 20 minutes. Add wort to fermenter while straining out hops. Top off to 5 gals. with cold water and pitch yeast. Add Cascade hops to secondary and dry hop seven to 10 days. Rack into keg and carbonate with CO_2 or bottle using corn sugar.

boil for 50 minutes. Add Cascade hops and boil 10 more minutes. The longer this beer is in the carboy, the better. Leave in carboy for at least 1.5 months. Prime with corn sugar.

OG = 1.070
FG = 1.018

Tess & Mark Szamatulski
Mike Sebas

Maltose Express
Monroe, Conn.

"One of the most popular styles brewers ask for is pale ale. We formulated this recipe because it's easy, delicious, and hasn't failed us yet!"

Never Fail Pale Ale
(5 gallons, extract/specialty grains)

Ingredients:
- 3.3 lbs. Munton's light extract
- 3 lbs. Munton's light dry malt extract
- 0.5 lb. crystal malt
- 1.5 oz. Northern Brewer hops (9% alpha acid), for 60 min.
- 1 oz. East Kent Goldings (5% alpha acid), for 5 min.
- 0.5 oz. Cascade hops (5.5% alpha acid), for dry hopping
- 1 tsp. gypsum
- Wyeast 1028 (London Ale) from starter
- 3/4 cup corn sugar for priming

Ed Megela

Brewers Corner
Scranton, Penn.

"This is a heavy, strong stout. The flavor is excellent and very smooth. It has a slight chocolate flavor."

Russian Imperial Stout
(5 gallons, extract/specialty grains)

Ingredients:
- 6.6 lbs. Northwestern amber extract
- 3.3 lbs. Munton's light extract
- 1 lb. crystal malt, 60° Lovibond
- 0.25 lb. roasted non-malted black barley
- 0.25 lb. black patent malt
- 2 oz. Eroica hops (13% alpha acid), for 60 min.
- 0.5 oz. Cascade hops (4.1% alpha acid), for 10 min.
- Wyeast 1084 liquid (Irish ale)

Step by Step:

Crush and steep grains for 30 minutes. Add extract and Eroica hops and

Steven Lonsway

Homebrew Market
Appleton, Wis.

"A fantastic extract brew with an all-grain taste. Perfect hop/malt balance on the palate with tremendous hop aroma. Definite German tones."

Reggae Red
(5 gallons, extract/specialty grains)

Ingredients:
- 6.6 lbs. Ireks unhopped amber extract
- 1 lb. light dry malt extract
- 1 lb. dark crystal malt, 60° Lovibond
- 1 oz. Northern Brewer hop pellets (8.4% alpha acid), for 60 min.
- 1.75 oz. German Hallertauer hop pellets (3.5% alpha acid), 1 oz. for 15 min., 0.75 oz. for 1 min.
- 1/2 tsp. Irish moss
- Wyeast 1007 (German ale yeast)
- 1 cup light dry malt extract for priming

Step by Step:

Add crushed grain to 2.5 gals. cold water and bring to a boil. Remove grains and add malt extract (both syrup and dried). Bring to a boil, and add Northern Brewer hops. Boil 45 minutes. Add 1 oz. Hallertauer hops and Irish moss and boil 15 minutes more. Total boil is 60 minutes. Add 0.75 Hallertauer hops at cool down. Top off to 5 gals. and pitch yeast. Primary ferment at 70° F for four to five days. Rack to secondary. Bottle when fermentation is complete.

OG = 1.050
FG = 1.010.

Mark DiSimone

Brew Masters Ltd.
Rockville, Md.

"This beer is silky smooth and has a great chocolate character. Its 10 percent alcohol is totally hidden. It is ranked number one in our 18-year history."

Nosfaratu's Return
(5 gallons, extract/specialty grains)

Ingredients:

- 6.6 lbs. gold unhopped malt extract
- 2 lbs. orange blossom honey
- 1 lb. chocolate malt
- 1 lb. pale chocolate malt
- 1 lb. Vienna malt
- 0.5 lb. cara-pils malt
- 0.5 lb. crystal malt, 56° Lovibond
- 1 lb. Munich malt
- 2 oz. Perle hops (8% alpha acid), for 20 min.
- 1 oz. crystal hops (3.2% alpha acid), for finishing
- Wyeast 1742 (Swedish ale)

Step by Step:

Steep grains in 2 gals. of 170° F water for 30 minutes. Remove grains. Add malt and honey to the grain water. Bring to a boil. Add Perle hops and boil for 20 minutes. Remove from heat. Stir in 1 oz. crystal hops. Add to fermenter. Add water to 5 gals. When temperature is below 80° F, pitch yeast. Ferment for seven to 10 days. Place in secondary for seven to 10 days. Prime with corn sugar. Bottle at 1.014. Let age three to four weeks.

Steve Bader

Bader Brewing Supply
Vancouver, Wash.

"This recipe is the most popular recipe in my store. We sell more than 450 of these each year. This recipe is very flexible. You can add fruit extracts to make fruit beers or add coriander and orange peel to make a Belgian white beer. (Change the yeast also to be true to style!)"

Hefe-Weizen and Berry Weizen

(5 gallons, extract with adjuncts)

Ingredients:

- 4 lbs. Premier wheat malt extract
- 1 lb. light dry malt powder
- 1 lb. wheat dry malt powder
- 1 lb. flaked wheat
- 1 oz. Tettnanger hops (5% alpha acid), for 60 min.
- Wyeast 3056 (Bavarian weizen) liquid yeast
- 3/4 cup corn sugar for priming
- Fruit extract of your choice to make a fruit ale (optional)

Step by Step:

Steep 2 gals. of hot water (about 130° F) with flaked wheat for 30 minutes with the heat on low (150° F). Strain out most of the flaked wheat, leaving some to give the beer its cloudy appearance. Bring to a boil. Remove the pot from the burner, add the malt extracts and hops. Boil for 60 minutes. When boiling is done, transfer the beer into 2 gals. cold water in your sterilized carboy, then top off to 5 gals. Add yeast when beer is cooled below 74° F, then ferment at 68° F.

If you want to make a fruit beer, add the natural fruit extract at the same time you add the bottling sugar. Raspberry, apricot, and boysenberry are great. Transfer the beer into your bottling vessel, then add the fruit extract to taste. One bottle of extract will give a hint of fruit flavor; 1.5 bottles will give a strong flavor. You may also bottle a few gallons without the fruit flavoring, then add the fruit extract and bottle the rest.

If you want to use raw fruit, the best way is to add 3 to 5 lbs. of crushed fruit into the wort when you are done boiling, and let the fruit steep for 15 minutes to extract color and flavor. Don't boil the fruit, because it will tend to give a very cloudy beer. You then strain out the fruit as the beer goes into the carboy.

OG = 1.044
FG = 1.013

Peter Norton
Geoff Deman

Liberty Malt Supply Co.
Seattle, Wash.

"The fruity malt nose and warming palate balance with a clean maltiness and dry finish.

Monk's Breath Abbey Ale

(5 gallons, extract/specialty grains)

Ingredients:

- 6 lbs. Liberty light malt extract
- 3 lbs. Liberty light dry malt
- 1 lb. De Wolf-Cosyns Belgian pale malt
- 0.5 lb. Briess victory malt
- 1 lb. clear Belgian candi sugar
- 2 oz. Czech Saaz leaf hops (2.6% alpha acid), 1 oz. for 60 min., 0.5 oz. for 5 min., 0.5 oz. at end boil
- Wyeast 3787 (Belgian Trappist high-gravity yeast)
- 3/4 cup sugar for priming

Step by Step:

Crack grains and steep in 6 gals. of 150° F water for 10 to 20 minutes in grain bag. Remove grains and add dry malt, stirring until fully dissolved. Bring to a boil. Add extract and candi sugar. Return to boil. Add 1 oz. hops. Boil 55 minutes. Add 0.5 oz. hops and boil five minutes more. Add last 0.5 oz. Saaz as you turn off heat. Steep for five minutes. Remove hops by scooping with a sanitized strainer. Chill well. Pitch yeast.

OG = 1.088
FG = 1.018-1.022

Owen Ogletree
Paul Eckloff

Brewtopia
Athens, Ga.

"This is a rich, smooth pumpkin ale with a nice sweetness and spiciness. It won third place in specialty fruit/spice beers two years ago in the Peach State Brew-Off in Georgia."

Pocahontas' Pumpkin Pleaser

(5 gallons, extract/specialty grains)

Ingredients:

- 6.6 lbs. amber malt extract syrup
- 1 lb. crystal malt, 40° to 60° Lovibond
- 1 oz. Willamette pellets, for 45 min.
- 1 oz. Styrian Goldings hop pellets, for 15 min.
- 2 lbs. canned Libby's all-natural pumpkin
- 3 cinnamon sticks
- 1 lb. honey
- 11.5 g. Edme ale dried yeast
- 3/4 cup sugar for priming

Step by Step:

Steep grain in 2 gals. of water while gradually heating kettle. Remove grains at 170° F. At boil add extract, pumpkin, and Willamette hops. Boil 30 minutes. Add two cinnamon sticks, honey, and Styrian Goldings hops. Boil 15 more minutes. Turn off heat and add last cinnamon stick. Add wort to 3 gals. cold water in fermenter. When cooled, pitch yeast. Primary ferment seven to 10 days and secondary one to two weeks.

Byron Burch
Nancy Vineyard

The Beverage People
Santa Rosa, Calif.

"This beer has overtones of both caramel and nuttiness, with hints of roastiness in the background, augmented by the lushness of two different kinds of Belgian candi sugar. Hops are very much in the background. Splitting the batch and employing two different yeast strains provides an interesting variation, with 1388 being notably the "cleaner" of the two and 3787 providing a richer complexity."

St. Seraphim Belgian-Style Strong Ale

(10 gallons, extract/specialty grains)

Ingredients:

- 7 lbs. The Beverage People light malt extract
- 6 lbs. The Beverage People amber dry malt extract
- 1 lb. Belgian cara-Vienne malt
- 8 oz. aromatic malt
- 4 oz. extra dark crystal malt, caramel, 120° Lovibond
- 4 oz. Belgian Special B malt
- 2 lbs. The Beverage People rice extract powder
- 1 lb. Belgian amber candi sugar
- 1 lb. Belgian dark candi sugar
- 1 tsp. gypsum
- 1.25 tsp. salt
- 1.5 tsp. chalk
- 9/10 oz. Eroica hop pellets (23.4% alpha acid), for 60 min.
- 1 pint Wyeast 1388 and 1 pint 3787 ale yeast starters
- 1.5 cups corn sugar for priming

OG = 1.072
FG = 1.016

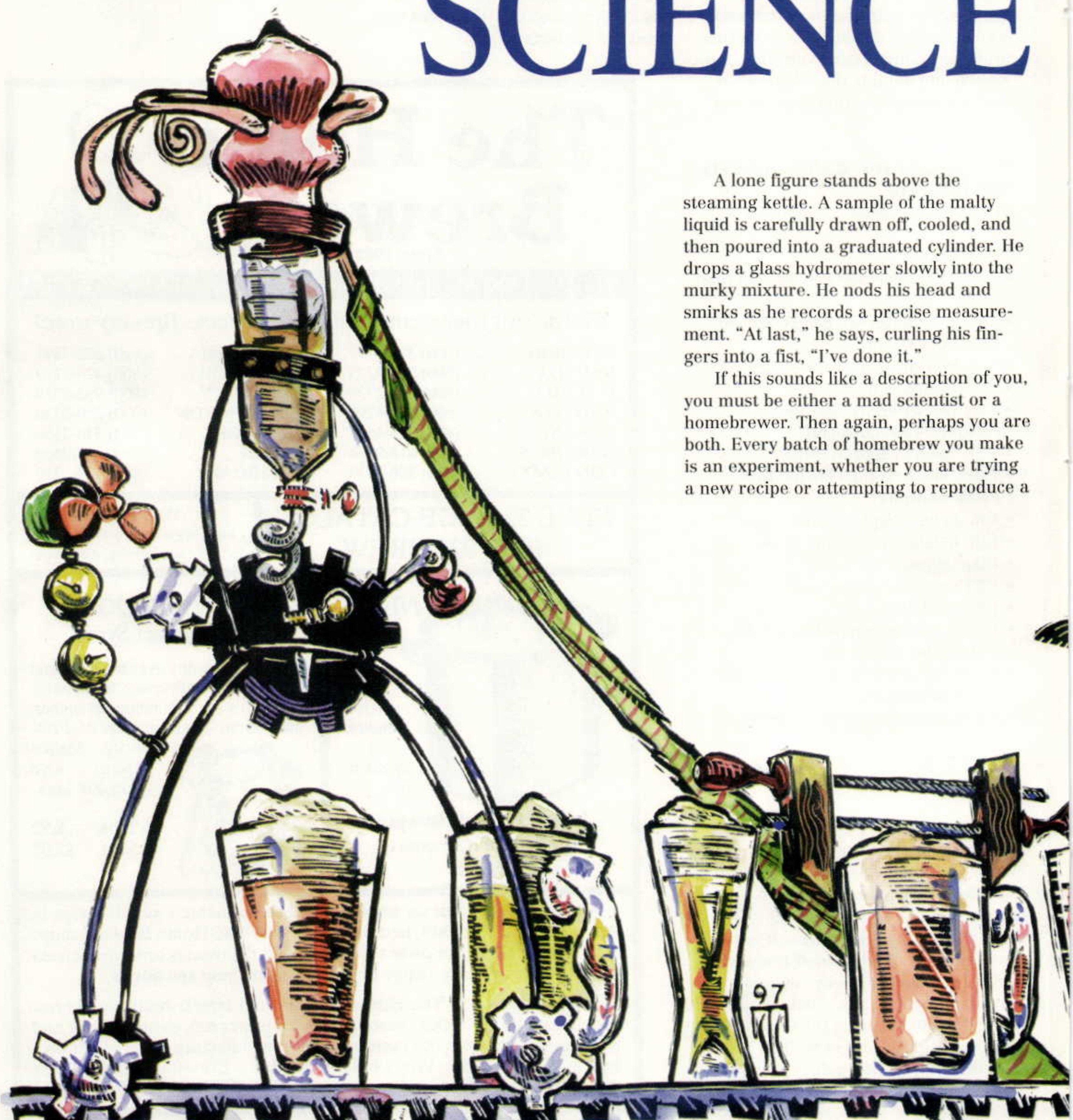
Step by Step:

Steep cracked grains in 150° F water for 45 minutes. Place grains in strainer or collander lined with cheesecloth and rinse with 150° to 160° F water, collecting runoff in the boiling kettle. When runoff is reasonably clear, discard grain. Add malt extracts, gypsum, salt, chalk, and enough water to bring the volume up to about 6 gals. Heat to boiling. When boil begins, add hop pellets and boil for an hour. Quick-chill the wort. Move the wort to fermenting vessels, filling them no more than 2/3 full, and add yeast starters. Ferment between 60° and 70° F. When fermentation appears to be complete, siphon to settling vessels, top them up, and let them stand for three to four days. Siphon to bottling containers, prime, bottle, and let the bottles stand for 10 days to two weeks to carbonate.

There's More...

Watch BYO's Recipe Exchange column for more featured extract recipes from homebrew retailers in coming months.

HOMEBREW SCIENCE



SHAWN TURNER

A lone figure stands above the steaming kettle. A sample of the malty liquid is carefully drawn off, cooled, and then poured into a graduated cylinder. He drops a glass hydrometer slowly into the murky mixture. He nods his head and smirks as he records a precise measurement. "At last," he says, curling his fingers into a fist, "I've done it."

If this sounds like a description of you, you must be either a mad scientist or a homebrewer. Then again, perhaps you are both. Every batch of homebrew you make is an experiment, whether you are trying a new recipe or attempting to reproduce a

EXPERIMENTS

by Alex Fodor

beer. You might be trying out myriad homemade gadgets every time you brew, as well.

Anticipating the outcome of these experiments makes brewing fun. One of the challenges of trying new ingredients and gadgets all the time is determining what exactly made your beer better or worse than the last. Was it the different hops, the extra crystal malt, the new yeast strain, or the shorter cooling time? With so many aspects of the beer constantly changing, it is difficult to tell. If you are interested in seeing the effect of a change in your brewing method or recipe, you should tackle the problem scientifically. Consider turning your beer into an experiment. However, keep in mind some guidelines:

- Only change one parameter at a time.
- Be consistent in your methods for sanitation, mash temperature, and cooling time. All of these things can change the flavor of the beer.
- Take scrupulous notes and label everything. By labeling and taking notes, you will be able to keep track of different treatments.
- Try to draw a conclusion and write it down. You can easily refer back to it and use your results to make better beers.

Each of the following experiments requires only one batch of beer. By splitting up a single five- or 10-gallon batch for different trials, you can avoid the variation that occurs between batches. Of course you will only be able to do this when experimenting with the beers after the boil. To see differences in hopping rates, hop additions, boil time, or mash temperature, you will have to brew more than one batch. The number of possible brewing

trials seems limitless. The following experiments just scratch the surface of possibilities.

Pitch Rate and Forced Wort

Next to sanitizing, pitching a proper amount of viable yeast may be the most important component of making great homebrew. A low yeast count at the start of fermentation will give bacteria and wild yeast an opportunity to grow and spoil the wort. A low pitch rate also results in more yeast growth and therefore more yeast by-products or flavor compounds. Pitch rate also determines how long you must wait for a finished beer because more yeast results in a faster fermentation.

This experiment requires that you set aside a portion of unfermented wort. This is called a forced wort test. It is an easy way to check your sanitation methods and demonstrates the value of adding culture yeast.

Materials:

- One homebrewed wort
- Two carboys
- One 22-ounce bottle
- Airlock
- Two seven-gram packets of dried ale yeast or two liquid yeast cultures of the same type

Procedure:

1. Prepare a beer and split it between two carboys. Sanitize a 22-ounce bottle and fill halfway with wort. Stopper the bottle with an airlock. This small portion of the wort will remain unpitched and will demonstrate the need for culture yeast in a successful fermentation. Microbial growth in the unpitched wort indicates contamination.

2. The two carboys should each contain about 2.5 gallons of wort. Open a packet of dried ale yeast. Using a sanitized measuring spoon, measure out one-half teaspoon of yeast and add it to the wort in one carboy. To the wort in the other carboy, add the full contents of a seven-gram yeast packet.

Although dried yeast is easier to measure, you can attempt this experiment with liquid yeast. Mix the liquid yeast thoroughly. Add a teaspoon of it to one wort and a full packet to the other.

3. Ferment the two worts in the same location along with the bottled wort.

4. When they finish fermenting, rack them off the yeast as you normally would. Note which beer finished fermenting first. Take a preliminary sample of the two beers to determine any taste difference. Remember to taste (or at least smell) the unfermented wort from the bottle along with the other samples. Note any differences. Discard the remaining unpitched wort.

5. Bottle or keg the beer as you normally would. Taste again and make notes. Predicting the exact flavor difference between your beers is difficult because results will vary. In general expect more off-flavors from both yeast and contaminants in the under-pitched beer.

Wort Aeration

In general, brewers try to keep their beer as far away from oxygen as possible. The one exception to this rule is wort aeration. Yeast need oxygen to conduct a swift and complete fermentation. At the start of fermentation, yeast use oxygen to make cell-wall components. If they fail to make enough, their ethanol tolerance may be lowered and they may fail to complete fermentation. Furthermore, the yeast may produce more esters (flavor compounds that contribute to the fruity, solvent-like, and floral aroma and flavor of beer) than normal and cause unwanted off-flavors.

For this experiment split a batch prior to fermentation, aerating one half and not the other. To add oxygen to the aerated half, you can splash the wort around or go a little more high-tech: a fish tank aerator.

One problem with the fish tank aerator is that there is a chance of contamination from the air. You can decrease the chances of contamination by adding an easy-to-make in-line cotton air filter. Take a three-inch length of brass pipe with 1/8-inch pipe threads on both ends. Stuff the inside with cotton. Screw a 1/8-inch brass hose barb to each end of the pipe. Sterilized it in a pressure cooker for 15 minutes. The plastic fish aerator tubing between the aerating pump and the stone slips easily onto the barbs. All the air from the aeration pump will pass through the cotton on its way to the wort aeration stone, which should be submerged in the beer. The air may not be completely sterile, but the cotton will remove many of the larger particles that float in the air, thereby reducing the chance of contamination.

Materials:

- One homebrewed wort
- Two glass carboys
- A fish tank aerator setup with homemade in-line air filter
- Two seven-gram packets or two liquid cultures of the same yeast

Procedure:

1. Prepare a five-gallon batch of beer. It is a good idea to make a higher-gravity wort (1.060 to 1.070) so that the yeast will be stressed and reveal how oxygen affects their performance.
2. Split the beer evenly between two carboys. You want to minimize aeration in one of the worts. When transferring the less-aerated wort, use a plastic tube that touches the bottom of the carboy to minimize splashing and oxygen pick up. Add the same amount of yeast to both beers. Use a neutral strain, such as Wyeast 1056, to keep matters uncomplicated. Split a seven-gram packet of dried yeast between the two.
3. Using the previously described setup, aerate one of the worts for an hour.
4. Observe the fermentation. Which beer starts fermenting first and which finishes first?
5. When the beers are finished, keep them separate. Note any flavor differences between the aerated and unaerated beers. The unaerated beer

should have more flavors from the yeast, such as esters, fusel alcohols (higher alcohols that contribute spicy, fruity, and wine-like flavors), and ethyl acetate (nail-polish remover).

Yeast strains

Choice of yeast strain is one the most important factors that determines beer flavor. Most beers are made from the same ingredients. Many breweries even buy their ingredients from the same suppliers. However, because of the unique yeast strains, their beers will never be likened to one another.

Different yeast strains produce different flavor compounds. Some yeast produce buttery diacetyl, others make fruity esters. Still others are known for clove-like phenolics. Or perhaps the yeast make few of these compounds and allow the malt and hops to predominate.

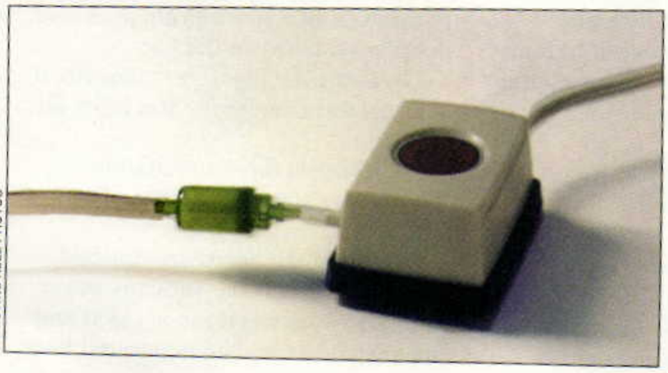
With so many new yeast strains available to the homebrewer, choosing a strain can be a challenge. Some brewers perform this simple yeast trial on a regular basis with whatever beer they make. For example a brewer who makes 10 gallons might add a different yeast to each five-gallon fermenter. Sometimes the two versions taste like completely different beers. You can easily perform this experiment by splitting a five-gallon batch.

Materials:
- One homebrewed wort
- Two carboys
- Equal amounts of two yeast strains

Procedure:

1. Split the wort equally between the two carboys. Add the different yeast strains to each carboy.

2. Unless you are comparing an ale and a lager yeast, try to ferment the beers in the same place (i.e. same temperature). Observe which yeast starts first and which finishes first. Does the yeast form a large head during fermentation? Does it settle out quickly or remain in solution?


CHRISTINE KELL PHOTOS

Using a fish tank aerator to add oxygen to wort will keep your yeast active. Healthy yeast produce fewer off-flavors.

3. After fermentation rack the beer, age, and bottle. Note the flavor differences in each beer. Also observe which beer is drier or sweeter. Record your results and use the knowledge you have gained to choose the yeast strain for your next batch.

Dry Hopping

Dry hopping is the traditional British practice of adding fresh hops to the secondary or conditioning tank. Certain flavor compounds are extracted by this method that cannot be achieved by late hopping in the kettle. These compounds are typically very aromatic and volatile. When the hops are added to the kettle, these compounds either dissipate into the air with steam or later blow off with carbon dioxide during fermentation.

Dry hops add complexity to beer. Different hop varieties will add different characters to the smell of the beer. For this experiment choose four hop varieties that interest you. You can use whole or pellet hops. Try Hallertauer, Tettnanger, Saaz, and Cascade for an interesting comparison of aromatics. You might also try comparing domestic and imported versions of the same hop variety, pellet and whole versions of the same hop, or different amounts of the same hop. If you use a high-alpha variety, you might find that it has harsher flavors than the traditional low-alpha aroma hops.

Homebrew experiments can be simple. A bottle of unpitched wort is a control in a pitch-rate experiment. Try different colored bottles to test for lightstruck beer.

Materials:

- Five gallons of freshly fermented homebrewed beer made with a neutral ale yeast
- Five one-gallon glass apple-juice jugs with airlocks
- Four different hop varieties

Procedure:

1. Make five gallons of a pale beer

with a mild malt character, such as pale ale, so that the flavors from the hops are evident. Add the bittering hops at the start of the boil to avoid extracting too much late-hop character.

2. As the fermentation comes to a close, rack the beer into five one-gallon jugs. Fill one of the jugs to the top and set it aside as the control test. Make sure to allow space in each of the other jugs for the addition of hops.

3. Add one-fourth ounce of a different hop variety to each of the four glass jugs.

4. Age for a week.

5. Rack each beer into a sanitized empty jug. Dissolve one-half tablespoons of priming sugar in water for each beer. Then bottle and label according to hop variety.

6. After the beers have carbonated, gather some friends and have a blind tasting. Tape a piece of paper over the bottle labels and number them one to five. Try to come up with a distinct aromatic profile for each beer. Rate them for preference on a scale of one to five. When you brew again, use your favorite hop.

Carbonation

Many homebrewers tend to go the extra mile to make a perfect beer when they buy ingredients. They buy special imported malts, hops sealed under nitrogen in protective bags, and unusual yeast strains isolated from foreign brews. As many professional brewers have learned the hard way, all this extra effort is of little value if the beer is not processed correctly after fermentation. This includes pinpointing the carbonation. Surely, few brewing misfortunes are worse than serving finely brewed beer at a party only to find its high carbonation brings a chorus of belches rather than accolades. Or even worse, the foam shoots to the ceiling and your beers are mistaken for party favors.

Carbonation can be a particular challenge if your beer volume changes from batch to batch while the amount of priming sugar added stays the same. The solution is simple. The commonly recommended three-fourths cup of corn sugar is for five gallons. This is about 2.5 tablespoons of sugar per gallon. To figure out how much beer you have in your carboy, you must mark the volume on the side of the carboy in one-gallon increments. This simply requires that you take an empty carboy and add one gallon of water (one full grocery store plastic water bottle). Then with a permanent pen mark the water level on the glass. Add a second gallon and mark the new volume until you have measured and marked five gallons one by one. The next time you want to bottle, refer to the marks on the carboy and calculate the amount of priming sugar by multiplying the volume in gallons by 2.5 tablespoons. If the volume of the beer is about 4.5 gallons, you will add about 11.25 tablespoons of sugar.

There is no holy commandment of brewing that requires the brewer to add priming sugar at a ratio of three-fourths cup per five gallons. This experiment explores some different carbonation levels and leaves the ultimate decision up to you.

Materials:
- One homebrewed beer of your choice (ready to bottle)
- Priming sugar
- One-gallon jug
- A bottling setup

Procedure:

1. Prepare four different priming doses using 1 tablespoon, 1.5 tablespoons, 2.5 tablespoons, and 3 tablespoons of priming sugar. Dissolve each amount into 1 cup of water separately and boil over low heat for 15 minutes.

2. Pour the solution into a sanitized one-gallon jug. Cover and allow to cool.

3. Rack a portion of the beer from the carboy into the jug until it is filled. Swirl the jug to make sure the sugar solution is mixed.

4. Bottle the beer from the glass jug as you normally would. Make sure to label the amount of priming sugar used on each bottle. Repeat steps one to four for all four amounts of priming sugar.

5. Bottle the remaining beer as you please, because it is not part of the experiment. You may wish to consume it immediately to lessen the toils of bottling.

6. After two weeks to one month, check a few of the bottles to see if they are carbonated. If not, wait another two weeks and try again. When they are ready, line up a row of glasses and pour each of the four beers. They should all have different carbonation levels. Choose the level you prefer. When you bottle your next beer, multiply the amount of sugar you liked by the number of gallons in your carboy as previously described. Bottle and enjoy a beer carbonated to your taste.

Bottled Beers

If beer could talk (not to mention feel and think), it would probably request to be served on draft rather than bottled. After all, bottling exposes beer to flavor-damaging oxygen and numerous sources of contamination. Somehow the convenience of bottled homebrew outweighs any contrived preferences our beer might have. Still, there are ways to keep beer fresh even in the bottle. In the following experiments bottled beers are exposed to different conditions and the consequent effects on flavor are evaluated.

Oxidation

The first experiment requires that you bottle beer with a large headspace, so that oxygen will react with the beer. Although bottling beer with live yeast helps reduce oxygen, there is a limit to how much oxygen the yeast in the bottle can gobble up. The rest will react with the beer, causing stale flavors reminiscent of cardboard.

Materials:
- Homebrewed beer ready to bottle
- Bottling setup

Procedure:

1. While bottling, fill three bottles three-fourths full and cap. Fill three more bottles almost to the top and cap.

2. Keep the bottles at room temperature. Taste a set of samples, a low fill and a normal fill, at two weeks, one month, and two months. Note any flavor differences between the two beers. The beer that has more air should degrade faster and have flavors typical of oxidized beer.

Lightstruck

In the second experiment beer is bottled in green or clear bottles and exposed to sunlight. The light causes a chemical degradation of certain hop compounds in the beer. The result is a beer that smells like skunk. One sniff should be enough to convince you that brown bottles are superior.

Materials:

- Homebrewed beer ready to be bottled
- Green, clear, and brown bottles

Procedure:

1. Bottle the beer in at least one clear bottle, one green bottle, and two brown bottles.

2. Place clear, green, and brown bottles filled with beer in the sun for a few hours. Leave another bottle in a dark place indoors.

3. Arrange four glasses in a row. Pour all of the beers and taste them. The beer from the clear and green bottles should have a distinct skunkiness that is not present in the beer from the brown bottles. It is a wonder so many beers are still packaged in these bottles.

Bottled-Beer Force Test

Commercial breweries usually keep a library of bottled beers on hand that are labeled by bottling date. One set might be kept at room temperature or in a warm incubator and the other in a refrigerator so it will not spoil. You can do the same thing with homebrew. By comparing room temperature and refrigerated samples over time, you can track the flavor progression of your beer as it ages.

Materials:

- Four pairs of bottled beers

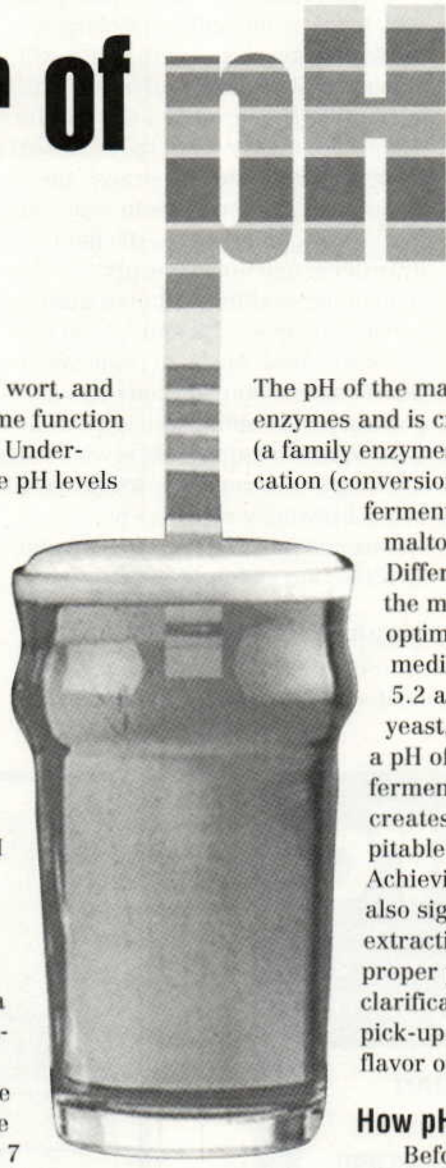
Procedure:

1. As soon as the bottled beers are carbonated, reserve eight bottles and label them with the date. Place four of the bottles in the fridge. Store the others at room temperature.

2. Pull out pairs of the bottles and taste the beers at two weeks, one month, two months, and three months. The flavor change over the course of time will vary. Some beers may oxidize, creating cardboard and toffee or sherry notes in the beer. Others may become buttery, sour, or phenolic due to wild yeast or bacterial growth. The autolysis of yeast in the beer will also add new flavors such as soapy, sulfury, and rubbery.

The Power of pH

by Nico Freccia



The level of pH in your mash, wort, and beer affects processes from enzyme function to hop extraction to yeast vitality. Understanding pH helps you manipulate pH levels for great-tasting beer.

But while pH is important, trying to understanding it can be a confusing affair. Your homebrew shop carries pH test strips and probably more expensive and elaborate pH meters. People talk about the pH of water, the mash, and the wort. But what is pH, what is important about it, and what do you really need to know about pH as a homebrewer?

What It Is

The term pH expresses the degree of acidity or alkalinity of a solution, in which "p" is the negative logarithm of "H," hydrogen concentration ($pH = -\log[H^+]$). The level of pH is measured on a scale of 1 to 14, 7 being neutral, below 7 acid, and above 7 alkaline (also called basic). Because the scale uses the exponent of 10 in the logarithmic scale, a solution of pH 5, for example, will be 10 times more acidic than a solution of pH 6 and 100 times more acidic than a pH 7 solution.

Technical definitions aside, what does pH mean, in a practical sense, to the homebrewer? The pH of the mash affects the activity of enzymes and is critical for the amylases (a family enzymes) responsible for saccharification (conversion of malt starch into fermentable sugars, particularly maltose) and liquification. Different enzymes required in the mash function at different optimum pH levels, but a happy medium is achieved between pH 5.2 and 5.5. This means healthy yeast, which also perform well at a pH of about 5.5. As the yeast ferment the wort, pH drops and creates a more and more inhospitable environment for bacteria. Achieving the proper mash pH will also significantly affect hop extraction rate in the boil, facilitate proper protein precipitation, clarification of the wort, and color pick-up, and ultimately affect the flavor of the beer.

How pH Functions in Brewing

Before manipulating pH to achieve optimum levels in the mash and wort, it is wise to review some basic principles of chemistry and biology. A fundamental quality of biological systems is their ability to maintain homeostasis (stay the same). Though systems constantly exchange materials with their surroundings, they will maintain a relatively stable internal environment. The maintenance of a stable pH and resistance to sudden changes in pH is an example of this quality. Where pH is concerned, systems maintain this stability through the use of "buffers." For example because of buffering in the human body, we are able to drink beer, which has a pH of 4 to 4.5, while our blood maintains an extremely constant pH of about 7.4.

In a solution of pure water (H_2O) at neutral pH 7, some water molecules will ionize, or dissociate, into H^+ ions and OH^- ions. Because the water is pure, there will always be the same number of H^+ and OH^- ions. However, when a compound that contains H^+ ions is introduced into the water, the H^+ ion concentration will increase. The greater concentration of H^+ ions causes the water to become more acidic, and so the pH drops. Buffers maintain a constant pH because they combine with H^+ ions and either remove them from solution (as in this example) or add them back, essentially "soaking up" the acid or base. If enough acid or base is added, it will eventually overcome the buffer and the pH will rise or fall accordingly.

Malted barley contains phosphates, which are acidic buffers. Making a mash of grain mixed with water will cause the phosphate buffers to achieve a natural pH of around 5.6. Therefore, it does not matter what the initial pH of your brewing water is because the interaction between ions in water and buffering components of the malt will always change the water pH. Remember that the optimum mash pH range is between 5.2 and 5.5, so the pH of the mash needs to come down a bit to ensure complete conversion, good hop utilization, and other desirable characteristics. This is where the brewing water comes in. While the pH of the brewing water may be inconsequential, its ion concentration is of the utmost importance.

pH and Brewing Water

Being familiar with the mineral content of your water can help you achieve the proper pH in you mash. All municipal water suppliers publish a water quality or water analysis report that they will send you upon request. If you brew with well or bottled water, you should have the water tested or contact your water supplier for an analysis. If your water supply comes from a river that has varying levels or is subject to fluctuations due to rainfall, ion concentrations may vary greatly at different times of the year.

The important ions that will affect mash pH are calcium, magnesium, and the carbonate and bicarbonate ions. These ions should be listed on your water report in either parts per million (ppm) or milligrams per liter (mg/l) — they are equal measurements. Calcium is the key ion able to overcome the buffering capacity of the malt phosphates and lower the mash pH into the acceptable 5.2 to 5.5 range. Ideal concentrations of calcium should be between 50 and 150 ppm. Magnesium acts much the same as calcium, but it is less effective at reducing mash pH. Ideal calcium concentrations, however, must be balanced with low carbonate-bicarbonate levels. Carbonate and bicarbonate ions will have a countering effect on calcium. Bicarbonates in particular are strong alkaline buffers and in large amounts will raise the pH of the mash to unacceptable levels. Carbonate and bicarbonate ions should be kept to less than 50 ppm.

The carbonate and bicarbonate ions will often be lumped together on a water report and termed "CO_3." They may not be listed separately, but they might be included under the headings for alkalinity and hardness and termed "$CaCO_3$," which describes alkalinity and hardness as the combined presence of calcium and the carbonate and bicarbonate ions. You should compare the two numbers for alkalinity and hardness. If the alkalinity rating is greater than the hardness rating, you may need to remove carbonate ions from the water to avoid raising the pH of the mash. If the hardness rating is greater than the alkalinity rating, the ratio of calcium to the carbonate ions is probably well suited to brewing. If the two numbers are equal or are both low (less than 50 ppm) you will probably only need to add some calcium from calcium sulphate or calcium chloride back to the water to make it satisfactory for brewing.

Manipulating pH in the Home Brewery

As we have seen, ion concentration in brewing water will have a great effect on the mash pH. Type of malt is another important contributing factor. Dark malts, for instance, are naturally acidic and will overcome the buffering power of carbonate waters, dropping the pH into the correct range. For the time being let's assume we're brewing only pale beers.

Remember that changes to the pH of the mash, wort, or beer will be due to the addition or removal of mineral ions or the addition of organic acids. Adding mineral salts is the most common way to adjust mash pH. Mineral salts, such as gypsum, are compounds formed by a positively charged ion and a negatively charged ion. Gypsum combines the calcium ion with the sulfate ion and is an excellent source of calcium to aid in acidifying the mash. Adding one teaspoon of gypsum to five gallons of water will raise the calcium level by about 60 ppm. If your brewing water is very soft (low in total minerals), you can add gypsum to raise calcium levels. If your water is high in carbonates, boiling the water for 30 minutes with calcium (either present in the water or added in the form of gypsum) will cause the calcium and carbonates to combine and precipitate out, forming a white residue in your kettle. Decant the water off the residue, leaving the carbonates (and calcium) behind. Because you've just removed much of the beneficial calcium as well as the detrimental carbonates, you may need to add gypsum to the water to raise calcium levels again before mashing.

If you want to brew a classic pilsner using pale malts and soft water, you may want to employ an acid rest to ensure the pH drops to the correct range. During an acid rest, the enzyme phytase breaks phytin, a phosphate containing both calcium and magnesium that is found in the grain, down into phytic acid. In other words, phytase helps lower the mash's pH. This is particularly important for water that has too little calcium to lower pH, such as the water of Plzen, the original home of pilsner. The enzyme works best at temperatures between 86° and 128° F.

The acid rest will acidify the mash to the proper range and will also provide minerals and nutrients for the yeast. An acid rest will be unnecessary for beers made using any highly kilned malts such as crystal and dark malts and even British pale malts, because these malts will be acidic enough on their own to lower the mash pH.

The other alternative to acidifying the mash is to add lactic acid. Lactic acid blends very well with beer and will not add any unwanted flavors. You should be able to find it in your homebrew shop along with instructions for use.

Again, dark malts are naturally acidic and will lower the mash pH. Even crystal malts will have some acidic effects, and the simplest solution to poor brewing water is to use a proportion of dark malts. Many great brewing centers of the world, particularly London, Dublin, and Munich, have water low in calcium and high in carbonates. The alkalinity of the water makes brewing pale ales or lagers difficult without acidification of the mash. But because they traditionally brew darker beers, such as porters, the acidity of the malt is able to overcome the buffering of the carbonate water.

pH and Sparge Water

The pH of the sparge runoff should be below pH 6. Higher pH couples with too high sparge water temperatures to extract tannins, silicates, and other undesirable compounds from the grain, which create astringent off-flavors and cloudy, hazy beer. Too high pH should not be a problem because the sparge water will mix with the mash and its pH will naturally be lowered. However, if your water supply is highly alkaline and you treated it by boiling to precipitate out calcium and carbonates for the mash, you should do the same to the sparge water. Using untreated, highly carbonate sparge water may raise the pH of the runoff above acceptable levels.

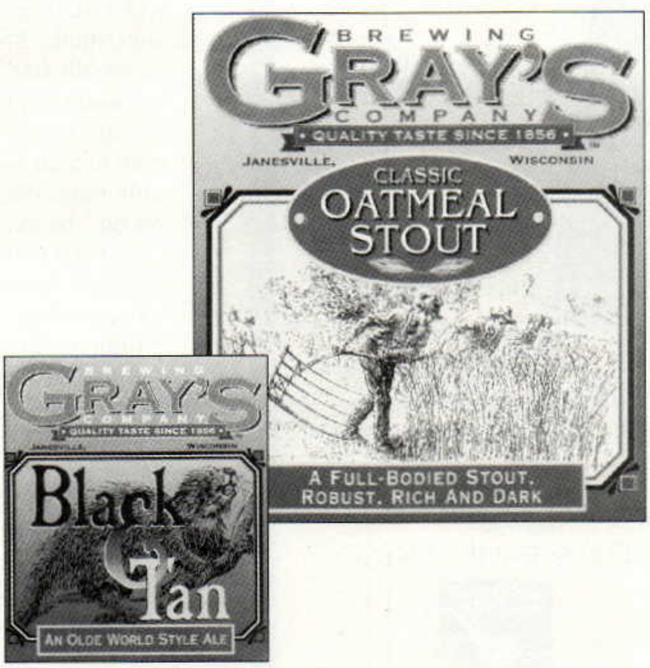
Unless you are brewing very specialized beers using undermodified malts, very pale malts, or soft water, you shouldn't worry too much about pH. You may need to make some adjustments such as boiling or adding gypsum, but for the most part the wort will take care of itself. Expensive pH meters will give you very accurate pH readings but are probably only necessary if you are aiming for very specific results. ■

Five Generations and Counting

by Stan Hieronymus and Daria Labinsky

The Gray Brewing Co. might have named its beers Phoenix when they debuted in 1994 were it not for the rich brewing tradition already associated with the Gray name. Like the mythical beast that rose from the ashes, the brewery was built from the ground up after an arson fire swept through the family's soda bottling plant in 1992.

The Gray family had been operating a soda company in Janesville, Wis., since 1856, so there was no question that they would rebuild. The question instead was what shape the company would take. Before Prohibition it made beer as well as soda, but increasing anti-alcohol sentiment led to the decision to give up brewing in 1912. This judgment proved wise, because the soda business kept the company alive, while small breweries continued to feel the effects of Prohibition for 50 years after the law was repealed.



After the fire — for which no one was ever charged — the Grays decided to return to beer. "I was homebrewing at the time and was interested in brewing," says Fred Gray, the fifth generation to work at the company that J.C. Gray founded in 1856. "We were originally a small brewery with a soda plant. I thought it was time to start over where we really began."

Fred persuaded his father, Robert, to add brewing equipment when the soda bottling plant was rebuilt. They already knew how to run a beverage business, from bottling to distribution to dealing with bureaucracy, and they applied that knowledge toward beer. Robert, the president, had years of experience working with soda distributors and salesmen as well as expertise in bottling and production. Fred, who started in sales for the company, became vice president, and his brother, Tim, has since joined the brewery as director of sales. Counting them, the brewery employs 12 full time.

Construction on the warehouse-style brewery was completed in late 1993, and by January 1994 the first batch of Gray's beer was ready for sale. The brewery sold 1,800 barrels that year and took home two gold medals from the 1994 Great American Beer Festival. Despite the national attention the awards drew, the Grays decided to focus on building a strong Wisconsin base. Business more than doubled to 4,800 barrels in 1995 and grew past 7,000 in 1996. Virtually all of that beer was sold in Wisconsin, where consumers are both loyal to local products and receptive to new things.

Gray's Honey Ale, one of the first commercially brewed honey beers, is available on draft at more than 80 spots in Dane County alone. The county is home to the University of Wisconsin and the state capital, Madison, which Fred Gray describes as "an island of its own." Madison is also the best market for two other successful microbreweries, Capital Brewing Co. and New Glarus Brewing Co.

The Honey Ale is made from four kinds of malt, four types of hops, and locally produced honey. It accounts for about 35 percent of total sales, and the brewery goes through about seven 55-gallon drums of honey a month. "The Honey is the toughest beer to brew because it's so thin," Fred Gray says. It is 4.9 percent alcohol by volume.

Gray's Honey Ale was one of the two GABF gold medal winners. The second winner was Gray's Oatmeal Stout, which is made with five types of malt, American-grown German hops, and about 15 percent oats. The beer is finished with Cascade hops, which are balanced with plenty of roasted barley. Oatmeal Stout is a full-flavored beer with 5.6 percent alcohol by volume that has continued to win awards, among them a bronze at the 1996 World Beer Cup competition.

Other year-round beers are Gray's Pale Ale and Gray's Black and Tan. The Pale Ale is made with four malts and three hops, including a solid dose of Cascade hops, and has an alcohol by volume content of 5.7 percent. The Black and Tan is a mixture of a pale ale and stout that are different from Gray's Pale Ale and Oatmeal Stout. "The stout is a little more of a bitter stout. I think it complements the tan part nicely," Fred Gray says. "One day we brew the tan, then when it's at high krausen we blend the black into it." It measures 5.1 percent alcohol by volume.

Seasonal offerings include Irish Ale, the Bavarian-style Wisconsin Weiss, Autumn Ale, and Winter Porter. All the beers except the weiss are made with a proprietary British yeast. Gray's acquired the yeast from a brewer and had it cultured at the University of Wisconsin. Only a few brewers in the United States have access to this yeast.

The brewery uses Janesville water but sterilizes and rebuilds it for brewing purposes. "The municipal water source is not always 100 percent consistent," Fred Gray says. In fact Janesville has more than one source for water, and the brewery can never be sure which one is in use. "Our concern for our water stems from our soda days. It's 90 percent of everything we do," he says.

Gray's prides itself on producing a consistent product, which is primarily a result of blending. Head brewer Greg Hammond brews 25-barrel batches and transfers them to 100-barrel fermenters. "You can blend four batches at once, which really helps our consistency," Fred Gray says. The brewery also has its own lab and lab technician, Assistant Brewer Michael Cain.

A tour of the brewery begins in a small tasting room/gift shop that's decorated with photographs, bottles, trays, and other memorabilia from the company's earliest days as a brewery and soda maker. From there visitors travel to a compact brewing room, then into a massive all-purpose room that contains the fermenters, holding tanks, and kegging and packaging equipment. In the

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back room is storage and cooler space.

The brewing equipment comes from several manufacturers, and the mash/lauter tun is a converted dairy tank. "You can call (a manufacturer), but I think it's a lot more fun to go to a farm auction and say, 'I've got a buddy who can weld. Hey, we can make that into a lauter tun,'" Fred Gray says.

Gray's has two four-arm keg fillers, and each arm is capable of filling 60 kegs a minute. The fillers were originally made for Anheuser-Busch, but A-B never used them. Gray's bought them from another Wisconsin brewery. A-B has since tried to buy them back. The bottling line dates to 1962 and can fill 150 bottles a minute.

Gray's still makes four kinds of soda that are available throughout the state of Wisconsin and in northern Illinois. Fred oversees the soda operation — which uses different equipment than the brewing side — and supervises the blending himself. The recipes aren't even written down.

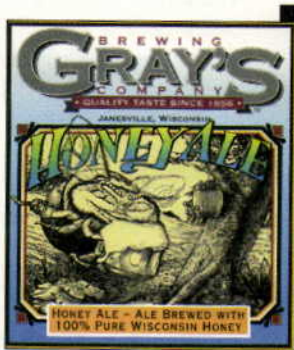
"My dad and I are the only ones who know them," he told a group touring the brewery.

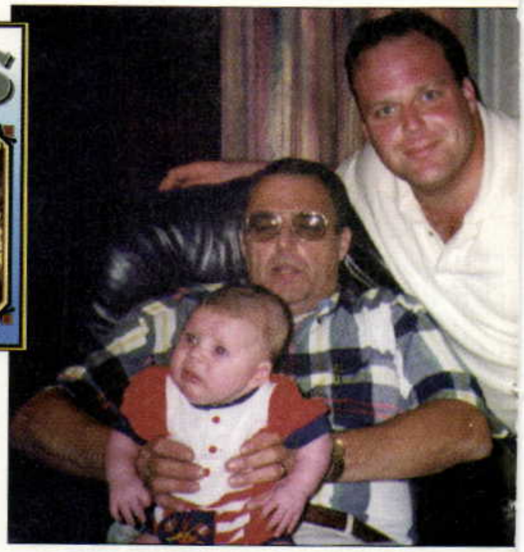
"Does that mean you can never travel together?" one tour member asked, jokingly.

"We do everything together," Fred responded.

Perhaps that's why the company has survived nearly 150 years as a family operation. "My dad never pushed me into the business," Fred Gray said. "I did other things and then came back into the business." However, he looks forward to the day his son, now one year old, becomes the sixth generation involved. "I'm more hyper on that than (my dad) was," Fred said. "I'm a big fan of Wisconsin breweries and brewing history...As my dad says, we're not necessarily the owners but the caretakers."

Gray's completed an expansion in November, adding 9,000 square feet of cooler and storage space as well as fermenters and packaging equipment.





Backed by Fred Gray (fifth generation), Robert Gray (fourth generation) holds the future generation of Gray brewers.

The expansion boosted capacity to more than 15,000 barrels per year. With the increase Gray's has begun to expand its distribution area. The beers are available throughout Wisconsin, in the Rockford, Ill., area and, since February, in the Chicago area.

"We're taking very small steps," Fred Gray says. "There was a demand for the product (in Chicago) and a distributor called us quite a while ago, but part of the romance of these products is the fact that people need to find them."

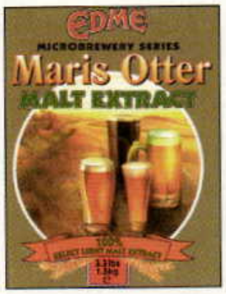
Gray Brewing Co. is located at 2424 West Court St. (State Route 11), Janesville, Wis. 53545. For information call (608) 752-3552. Tours are held the first and third Saturdays of each month at 1:30 p.m.; a donation is requested. ■

Stan Hieronymus and Daria Labinsky are authors of the Beer Travelers Guide, *which lists more than 1,700 brewpubs, bars, and restaurants in the United States that serve flavorful beer.*

Beer Essentials

Edme Adds Maris Otter

Edme has added Maris Otter light malt extract to its Microbrewery Series unhopped line. The "single varietal" malt extract is made from 100 percent Maris Otter malted barley.



Prized by British breweries for its unique sugar spectrum and flavor profile, Maris Otter is a low-nitrogen, traditionally floor-made, two-row malt.

The extract is available at homebrew supply shops.

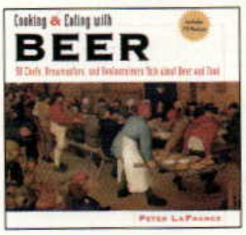
Relax, Don't Worry. Point and Click

The Interactive Complete Joy of Home Brewing With Charlie Papazian by MediaRight Technology Inc. is a multimedia CD-ROM for Windows PCs. It combines Papazian's book, a brewer's log, brewing calculators, and an instructional video. The CD-ROM lets homebrewers keep customized records of their sessions and perform complex calculations quickly and easily. The suggested retail price is $35.

The CD is available from retail and mail-order homebrew suppliers or by calling 1-888-746-3239.

Cook and Eat With Beer

In *Cooking & Eating With Beer: 50 Chefs, Brewmasters, and Restaurateurs Talk about Beer and Food*, beer connoisseur Peter LaFrance asks beer and food experts to share their appreciation for — and unique knowledge of — beer. Chefs recommend beer-food pairings and provide some of their favorite recipes.



To order the book call John Wiley & Sons Inc. at 1-800-225-5945.

Washing Made Easy

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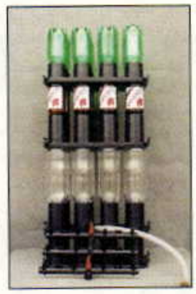


The Bottle Washer comes with a jet system, bottle tray, and hose with a standard fitting. Two models are available: a tray for wine/beer bottles and a tray for plastic 500-milliliter and one-liter bottles.

To order call (604) 590-1911. ■

Advertiser Index

BREWER'S MARKETPLACE

An Experiment Under Pressure

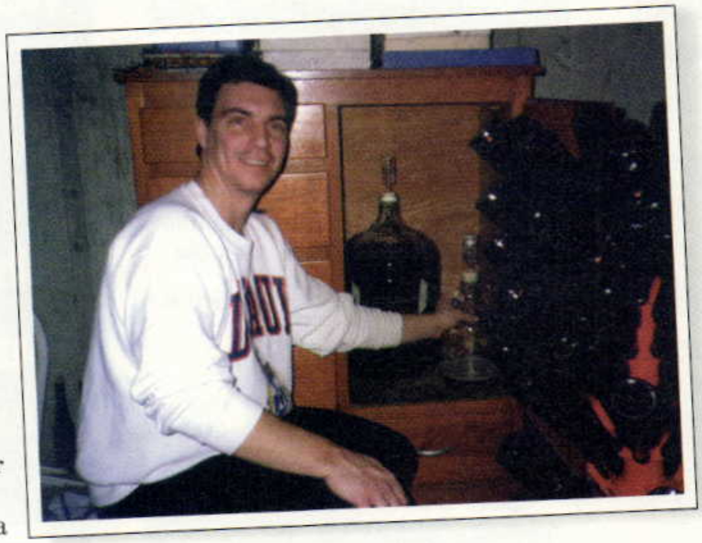
by Paul Kurjanski

Every homebrewer has his own particular story about a batch from hell. My problem came during an attempt to carbonate an English pale ale Bass clone.

Everything associated with the brewing process and fermentation actually went quite smoothly. I began to have problems when it came time to bottle. On the night that I bottled, all went as expected — up to a certain point. I boiled some corn sugar to prepare my priming solution and sanitized the bottles, bottle caps, bucket, hoses, bottle filler, and racking cane. I transferred the beer to the bottling bucket and began to fill my bottles. As I filled the next to last bottle, I leisurely glanced up toward the stove top, only to realize with a creeping sense of dread that my priming solution was still sitting in the pot, waiting to be used. Luckily, the caps were still resting atop each bottle, waiting to be crimped. Not wanting to empty each bottle back into the bucket for fear of splashing and oxidation, I quickly sanitized a small measuring spoon and "spoon fed" each bottle a small dose of priming solution. I stopped when it appeared as if I was in danger of overfilling the bottles. At this point I crimped the bottles, though I still had a fair amount of priming solution left in the pot.

Over the course of the next two months, I sampled a bottle here and a bottle there. The beer was relatively clear and tasted pretty good, although it was still extremely flat. I was about to chalk this batch up to experience. However, a thought occurred to me shortly after my wife, Janet, was kind enough to buy me a new kegging system for my birthday. What if I kegged the beer and force carbonated? After all, I really had nothing to lose except one flat batch of beer.

I tested my newly acquired kegging skills on a batch of spiced ale over the holidays. Once the keg was empty again, I decided the time was right to begin my experiment. I cleaned and sanitized all my equipment, gently opened each of the remaining bottles of pale ale (somehow there were only 24 left at this point), flame sterilized every bottle before gently pouring the contents into the bottling bucket, siphoned into the waiting keg, sealed the keg, and left it in the refrigerator overnight to chill.



These days I try to stick to bottles or kegs, not bottles then kegs.

The following evening I anxiously hooked up the gas line from my still shiny CO_2 tank, pressurized the keg, shook it until I began to break a sweat, and repeated the process until I was sure I had saturated the beer with CO_2. I was beginning to think all was not yet lost as I disconnected the CO_2 line. At this point I was curious to check out the carbonation level and decided to connect the beer line to the keg and pour myself a glass.

At this point disaster struck once again. The little black lever on the end of the beer line — the one you press when you want to fill your glass — must not have been tightly screwed back in place after it was cleaned. As I snapped the disconnect onto the pin lock, the pressure in the keg was enough to pop the lever right off the beer line. The result was something reminiscent of Old Faithful — a geyser of pale ale shooting into the air in my basement. I quickly grabbed a few pint glasses that were resting on top of the nearby beer refrigerator and began to panic as I saw how rapidly they filled up. My wife, who was in the adjacent family room, heard my anxious pleas for help and came into the room to investigate.

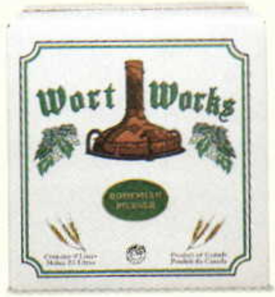
She quickly handed me a plastic gallon milk jug from the floor, and I plunged the beer line into the mouth of the jug. As the jug began to fill, I finally realized that those little pressure relief valves were put on the top of keg lids for a purpose. I pulled the relief ring and the keg quickly depressurized, stopping the flow of beer from the "beer fountain." The half-filled milk jug and the two pint glasses were now filled with a clear amber liquid beneath a nice, foamy head.

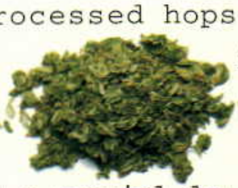
I turned toward my wife and asked her a simple question. "Thirsty?" ■

Do you have a 750-word story for Last Call? Mail it with a color photo to Last Call, c/o Brew Your Own, 216 F St., #160, Davis, CA 95616.

This is Sean. He's our beer guy.

Matter of fact, around Brew King, we call him "The Beer Guy". After all, he knows a thing or two about beer. And as you can see, he's pretty happy right now. Why? Because after months of self-imposed exile in Brew King's (windowless) brewing lab, Sean has emerged with Wort Works, an all-malt brewing kit of pure perfection - even by Sean's standards. You see, Sean belongs to that elite group of home brewing purists - the ones that scoff at most commercial brews and insist on choice natural ingredients for their own brewing masterpieces. With Wort Works, Sean would never cut corners. So what has Sean created? A totally unique, bag-in-a-box packaged product offering 9 litres (2 gallons) of concentrated wort made from 100% barley malt with naturally processed hops and filtered Canadian water, fully boiled in our 1000 gallon brew kettle. Sean even insisted on including a special dry hop package for extra aroma and flavour. And true to form, his instructions are comprehensive, even with information on the specific ingredients used. Sean's no dummy. He made Wort Works with his fellow homebrewers in mind, but he also made sure that its user friendly, no-boil method would be perfect for beginners too. Keep Sean happy. Make his Mom proud. Try Wort Works. The results will make you (and your friends) happy too.





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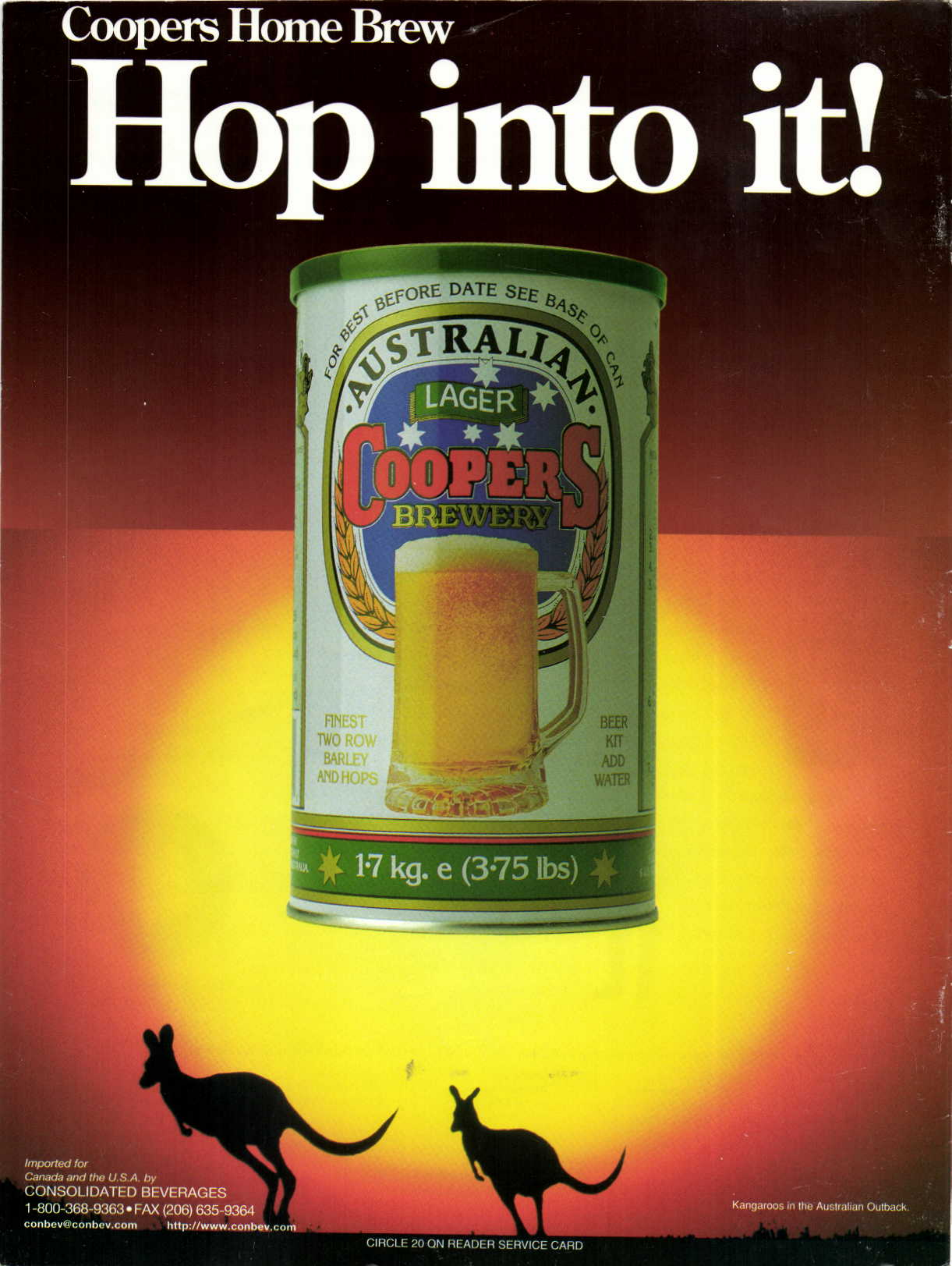
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