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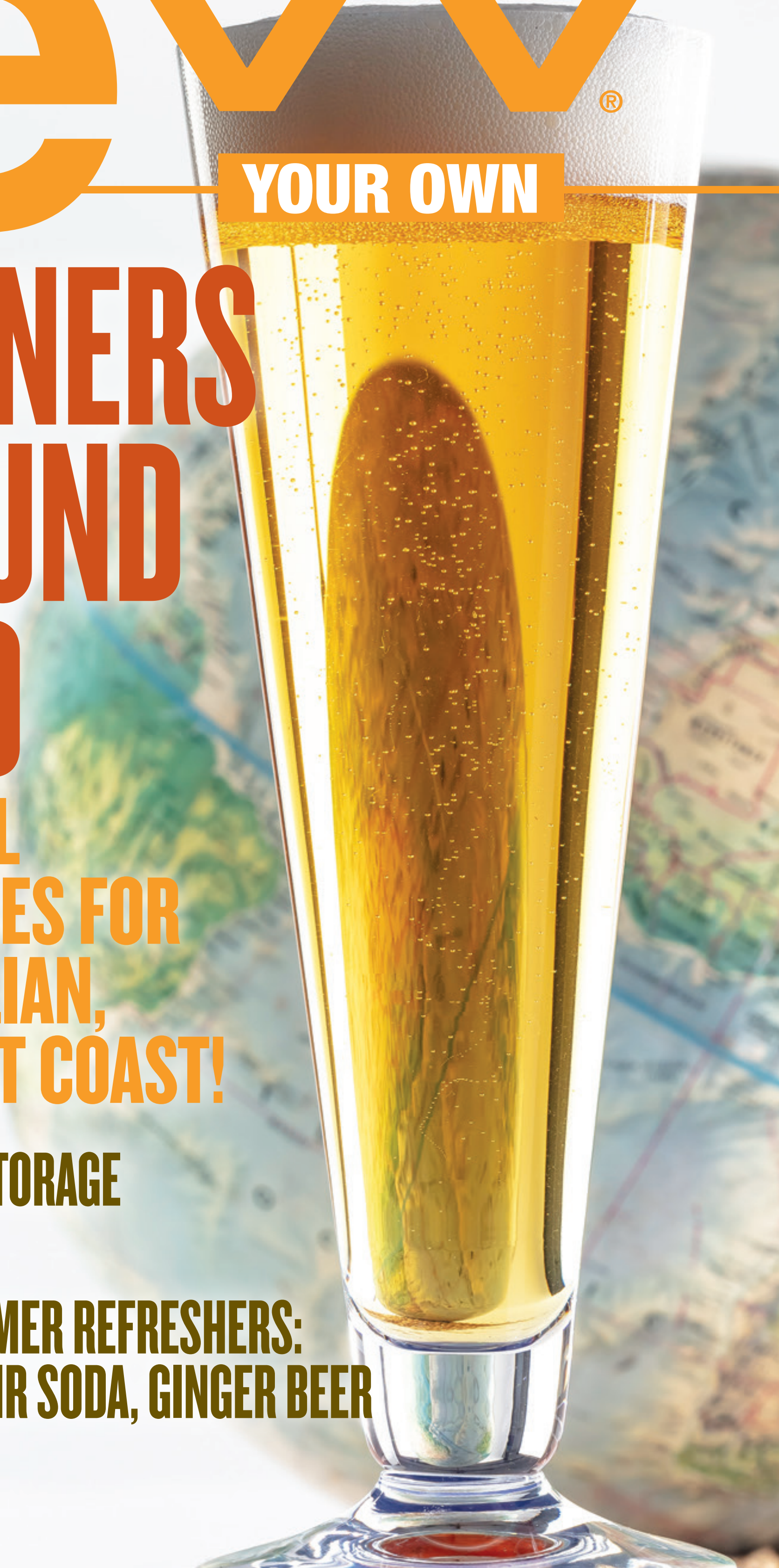
THE HOW-TO HOMEBREW BEER MAGAZINE

MAY-JUNE 2024, VOL. 30, NO. 3



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features

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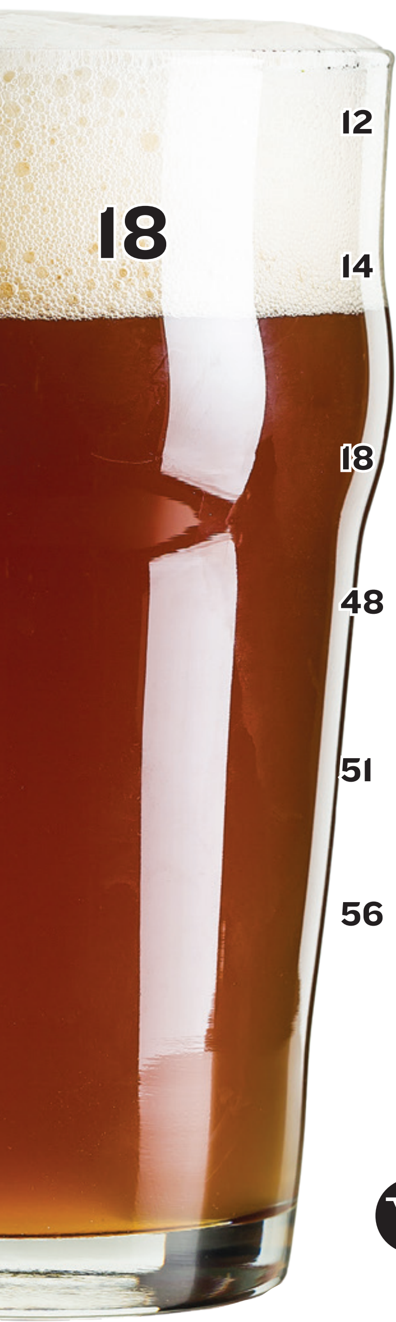
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where to find it

RECIPE INDEX

RECIPE STANDARDIZATION

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

EXTRACT VALUES FOR MALT EXTRACT:
liquid malt extract (LME) = 1.033–1.037
dried malt extract (DME) = 1.045

POTENTIAL EXTRACT FOR GRAINS:
2-row base malts = 1.037–1.038
wheat malt = 1.037
6-row base malts = 1.035
Munich malt = 1.035
Vienna malt = 1.035
crystal malts = 1.033–1.035
chocolate malts = 1.034
dark roasted grains = 1.024–1.026
flaked maize and rice = 1.037–1.038

HOPS:
We calculate IBUs based on 25% hop utilization for a one-hour boil of hop pellets at specific gravities less than 1.050. For post-boil hop stands, we calculate IBUs based on 10% hop utilization for 30-minute hop stands at specific gravities less than 1.050. Increase hop dosage 10% if using whole leaf hops.

Gallons:
We use U.S. gallons whenever gallons are mentioned.

Brew YOUR OWN
THE HOW-TO HOMEBREW BEER MAGAZINE

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Charles A. Parker/Images Plus

Q

Other than beer, what is your favorite fermented beverage that you make?

Without a doubt, it's cider. We have about a dozen apple trees and a nice cider press, so we make a couple batches a year. After experimenting with lots of different yeasts, I've settled on Wyeast 1450 (Denny's Favorite). It ferments dry but leaves a lot of apple flavor, so no backsweetening is needed.

There's no fermented anything I enjoy making more than fermented hot sauce. It's a liquid and I consume enough that I basically drink it, so that counts, right? But in recent years I've been experimenting with "woodsy" tonics, usually fermenting maple syrup and pine needles as a base. It's fun, allows for foraging local ingredients, and makes you feel like a druid!

I am partial to fermenting spirits (though I can't legally recommend you do this!) I also like fermenting ciders. I enjoy playing around with "found" and wild apples, but also the cider extract kits that are available are great.

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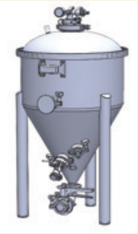
The Mysteries of Dark Lagers

When someone says "lager" it is usually a Pilsner or other pale, light beer style that first comes to mind. But there are plenty of lagers that don't fit that description. Explore the mysterious history of dark lagers; from when they were dark unintentionally to purposely, and the rise of bottom-fermented beers in Bavaria. www.byo.com/article/the-mysteries-of-dark-lagers/

Kombucha

Got fermentation fever? Kombucha — tea fermented with *Brettanomyces* and other microbes — may be a fun change of pace. Explore the history, brewing techniques, and recipes for this ancient fermented beverage that has boomed in popularity in recent years. www.byo.com/article/kombucha/

Fundamentals of Stainless Steel Conicals



Conical fermenters provide a lot of options for homebrewers that other fermentation vessels don't. Explore the various uses, benefits, and best practices of stainless conicals from the man who helped popularize them in the homebrew market two decades ago, John Blichmann. www.byo.com/article/fundamentals-of-stainless-steel-conicals/

Yeast Harvesting (Video)

Professional brewers regularly harvest yeast from one beer to reuse in a new batch. Now you can too with tips shared by *Brew Your Own* Technical Editor Ashton Lewis in this BYO+ video. www.byo.com/video/yeast-harvesting/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MAIL

EXCITEMENT FOR ALTBIER

I don't usually send comments to magazine editors and publishers, but felt compelled to do so this time. After reading Jamil Zainasheff"s article about "The Special Altbiers of Düsseldorf" in the March-April 2024 issue, I was totally impressed by nearly every aspect of the content. I felt like I was there in Düsseldorf! I have been brewing since 1985 and have been receiving this magazine since the first issue in 1995. In all these years, I have to say that was my favorite article! After reading the Brewers Publications *Altbier* book and many other articles, I thought I knew everything I needed to know to brew this style, but with this article I learned so much more! I hope you will let Jamil write a similar article about Kölsch beer in the future.

I also enjoy the writings of Gordon Strong, Ashton Lewis, Drew Beechum, Denny Conn, and many others over the years! Thanks for keeping *BYO* about brewing beer!

John Tipton • *Madison, Alabama*

Jamil Zainasheff's response: "Thanks for the email. It is always nice to hear that the work is appreciated and the only reason I do it is so people can have more fun brewing beer."

MAKING GRUIT

For our meadery in the Netherlands we want to try and make a gruit ale. I've been experimenting for two years now but never had the result I wanted. Most of them were sour, or the herbs were overpowering. But I don't want to give up on making a gruit ale with an ABV of 6.5%. I saw the "Style Profile" column and recipe for Gordon Strong's Gruit in the January-February 2024 issue and was intrigued as we also want to use kuyt (or koyt) as a base for the ale. The questions I have regarding making a gruit ale are:

1. What amount would you recommend for a 5-gallon (19-L) batch with herbs? The ingredients that I want to use are close to yours; bog myrtle, laurel berries, juniper wood, juniper or spruce tips, and juniper berries. Could I just use your amounts if I don't want an ale that's too bitter? I want to avoid herbs that aren't native to the Netherlands for historical aspects.

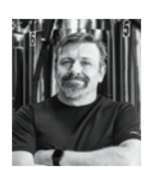
contributors

Trent Musho's journey into the world of brewing spans over a decade, marked by a passion evolved from experimenting with wine and cider kits to beer making. With a background in cinematography and photography, Trent shares those skills on his YouTube channel, *TheBruSho*. There, he imparts simplified instructions, guiding beginner brewers through the process of creating exceptional beer effortlessly. Trent also has a passion for all things fermented and shares recipes and techniques for simple home fermentation projects like kombucha, kefir, and tepache. All with the hopes of bringing new fermentation-curious folks into the awesome world of homebrewing their own beer.

On page 24, Trent shares techniques and recipes for making tepache, ginger beer, and kefir soda.

John Blichmann is the Founder of Blichmann Engineering, a design and manufacturing firm wholesaling highly engineered products for brewing and winemaking. He sold the company in 2023. John has more than 20 years of extensive product design (both mass-production and custom), testing, manufacturing, service, sales, marketing and management, all gained while he worked at Caterpillar in a variety of positions and locations. He ultimately "retired" as an engineering supervisor to focus on the design of high-quality brewing equipment. John has been an avid brewer since 1991 and is a BJCP judge.

On page 36, John discusses the benefits of pressure fermentation and how it can be done on homebrewing equipment, and shares results from his own tests to brew lagers under pressure at ale fermentation temperatures.



Keith T. Yager started homebrewing in 1996 with a hydrometer, a bucket, and a can of John Bull malt extract. In 2010, he co-founded Yellowhammer Brewing in Huntsville, Alabama, where he chalked up a few awards, including Brewmaster of the Year at the inaugural Alabama State Beer Championship in 2016. By 2020, the partnership had run its course and he took a buyout. In 2023, after brewing at a few other breweries, he purchased Cross-Eyed Owl Brewing in Decatur, Alabama, where he now brews and serves ales and lagers to thirsty locals from his downtown taproom. And, believe it or not, he still has that original hydrometer and brews occasional batches at home.

An excerpt on mash chemistry from his new book *Unlocking Homebrew: The Four Keys to Tasty Beer* begins on page 42.

2. Will these ingredients help in not making the gruit ale sour?

3. Are there other tips and tricks that you would offer in regards to brewing gruit?

Danique Staal • *Leek, Netherlands*

Gordon Strong's response: "I don't really have extensive experience making these so some experimentation is required. The natural products vary in intensity, so any batch brewed will involve some adjustments. I think it's perfect to use local ingredients, particularly since gruit is native to that region.

"About the sourness, is the kuyt sour on its own? Without hops, natural preservatives aren't present, so gruits are more subject to lactic souring over time and should be consumed young, and kept under refrigeration.

"The herbs will add some bitterness, but that is needed to balance the malt sweetness. It's a matter of personal preference as to the balance. Herbs tend to have more of an astringent bitterness than hops do, so that is also part of the profile.

"You can start with the ratios I suggest, and then make adjustments based on your tastings. This kind of beer is rarely perfect on the first batch, so adjustments are needed based on the ingredients you can find."

SMALL-BATCH RECIPES

I love getting your weekly newsletters and you do great work on them. Is it possible to sometimes share 1-gallon (4-L) recipes? I am an experienced homebrewer but sometimes I just want smaller recipes without having to recalculate everything. I also brew in a small apartment, so the small batches are easier to fit in.

Tamara Smith • *Montreal, Quebec*

Thanks for subscribing to the weekly newsletter! We always appreciate hearing about the ways our readers are enjoying the homebrewing hobby, and we'll keep the request in mind. That said, we don't have a lot of 1-gallon (4-L) recipes due to the fact that the survey we email out to a percentage of readers every fall always shows a very small percent brew in this volume (it was actually under 1% in the 2023 survey!). But if you do a search for "small batch" on our website you'll see the stories we've done on it, most of which have some recipes.

For those who may be curious what size batches most of our readers are brewing (though it should be obvious since our standard is 5-gallon/19-L batches for a reason), here are the results from our 2023 Reader Survey to the question "How large are the batches you make?"

***72%** 5–6 gallons (19–23 L)*
***14%** 10 gallons (38 L)*
***7%** Larger than 10 gallons (38 L)*
***6%** 2–3 gallons (8–11.5 L)*
***>1%** 1 gallon (4 L)*

While we're revisiting the 2023 Reader Survey, here are some more statistics readers may find interesting.

"What homebrewing method do you use (check all that apply)?"

***93%** all-grain*
***20%** extract with grains*
***16%** kits*
***11%** partial-mash*
***5%** extract only* (BYO)

WHAT'S NEW

UNLOCKING HOMEBREW: THE FOUR KEYS TO TASTY BEER

covers the hobby in a fashion that is approachable to first-time homebrewers, yet loaded with information that even longtime homebrewers can learn from. The book is built around four keys to successful brewing: Understanding water, cleaning and sanitation, yeast and fermentation, and avoiding oxidation. With decades of experience as a homebrewer and commercial brewer, Keith T. Yager explains how these keys play a critical role whether brewing extract, partial mash, or all-grain batches while detailing the steps of every method. The book concisely explains how to brew 1-gallon (4-L) and 5-gallon (19-L) batches. Available now in digital format from Amazon for $8.99. Find an edited excerpt on mash chemistry on page 42.

ANVIL BREWING PUMP-XP

Anvil's newest brewing pump has a high-temperature impeller that can move 6 gallons (23-L) of liquid per minute. It features a ½-inch NPT with tri-clamp head that allows for easy, tool-free disassembly for cleaning and runs on a 120V motor that operates quietly under 40 dB. Made of 304 stainless steel precision machined casting, the Brewing Pump-XP also features an air vent and discharge barb that makes priming quick and easy. Retails for $164.99. Learn more at www.anvilbrewing.com/brewing-pump-xp

BREWTOOLS MINIUNI+

Brewtools has upgraded the popular stainless steel MiniUni with the Mini-Uni+ that features the same benefits as the original but with a glycol jacket. These conical units are pressure rated to 30 PSI and can be used as fermenters, storage vessels, and for serving beer. The Plus-models come in three sizes — 7.9-gallon/30-L, 10.5-gallon/40-L, and 13.2-gallon/50-L. The cooling jacket comes with ⅜-inch NPT threaded ports to hook up to a glycol chiller and two 1.5-inch tri-clover ports in the front. Available in North America through MoreBeer!. Learn more at www.morebeer.com

Social Media Question

As homebrewers, we are constantly learning how to improve the beers we make. What's something you learned along the way that you wish you knew from the start?

Jason Chalifour: Simple recipes are usually the best recipes.

David Tomle: Not to stress about the small things and accept that small variations per batch are part of what being a backyard enthusiast experiences.

Athanasius Jude Phiri: I learned that green malt corn has as much diastatic power as normal barley malt.

NanoBrasserie Boyer: Take care of your yeast! Everyone can make a good wort. But yeast need specific conditions to make a good beer.

Will Schmit: I have been brewing for over 45 years. The thing I learned is to make smaller batches, more often. I'm not as strong as I used to be. Lugging a 7-gallon (26.5-L) fermenter to the basement is no longer a possibility.

Tim Taylor: Brew-in-a-bag. You get the same results with less equipment and cleaning.

Matt Seuberling: Focus on fermentation gear spending over brew-house. Good wort is useless if poorly fermented.

Patrick Chavez: The importance of keeping oxygen away from the finished beer, proper wort aeration, and using an electric kettle to boil gaskets and O-rings on the fermenter.

Denny Conn: It's only beer. Don't freak out.

Eric Townsend: Check the weather reports before starting an all-day 10-gallon (38-L) batch without a pop up!

MosEisley Brewing: How water profile affects different styles of beer.

froththegrothy: There is no such thing as too many notes.

billdraftnauts: Yeast makes beer. Good brewers take good care of their yeast.

Upcoming Events

MAY 4, 2024

Big Brew Day

Held on the first Saturday in May, Big Brew for National Homebrew Day is an opportunity to fire up the kettle and raise a glass to the greatest hobby there is — homebrewing! Check in with your local homebrew shop or visit: www.homebrewersassociation.org/aha-events/big-brew-national-homebrew-day

BYO **READER PROJECT**

HOMEMADE TAP HANDLES

JIM PRESTON • PICKERINGTON, OHIO

Photos courtesy of Jim Preston

Jim Preston shares his story on whittling tap handles for each beer he brews in "Last Call" on page 56. Here are some other photos of his tap handles that he makes from basswood using knives, gouges, and chisels. "First, I drill the bottom to put in a threaded insert for the tapper. Then, I transfer the design with graphite paper (or draw with pencil) and start carving. Once done, I lightly sand, then add a couple of light coats of spray matte finish clear coat to seal the wood. I use acrylic paint and after it dries, I use a very light wash coat of a burnt umber color acrylic to accent the details and tone down the brightness. Finally, a couple more coats of clear protective finish and you're ready to go."

BY DEREK DELLINGER

DEAR REPLICATOR,

Of all the unusual ingredients I've seen in craft beers over the years, I believe the black walnut dark wheat ale I encountered over in the Ozarks may have been a first. I would love to know how Piney River Brewing Co. created their Black Walnut beer!

Graham Curtiss
Dallas, Texas

In 2009, Joleen and Brian Durham were sitting by a bonfire in their backyard drinking Ommegang's Three Philosophers. It was a period during which the farm brewery concept was experiencing a renaissance in which Ommegang (based in rural upstate New York) arguably played a part in kicking off, years earlier. According to Joleen, it was at this moment that they realized they were ready for a new stage of life.

"We wanted to make an investment in ourselves and in our community, and the one thing that Brian and I always did together was brewing beer," says Joleen. At the time, the Durham's kept some beef cattle on their farm in Bucyrus, Missouri, but upgrading to a brewery was a significant leap in scale and effort. "In 2010 we started renovating a 1940s-era barn on our farm — shoveling out decades-old manure, throwing old hay out of the loft. We also drilled a new, deeper well because we only had an old, hand-dug well on our farm."

Eventually, the first level of the BARn (as the Durham's call it today) was where they started brewing and canning, while the loft seemed an ideal area for a spacious taproom overlooking the property.

Ever since then, the rural location of the brewery has continued to play a significant role in the Durham's efforts, frequently inspiring the sorts of beer they brew.

"There are lots of times when we're outside in the Ozarks and working on our farm that we are inspired to brew a style of beer based on a specific thing the Ozarks are known for," says Joleen. "Our Float Trip Ale is inspired by float trips on the many spring-fed streams in the Ozarks. This summer we have a German-style Pilsner coming out called Makin' Hay, which we hope is an extremely crushable lager like you would want to drink after a long day or during a break while making hay on the farm — a hard, hot, humid job in the Ozarks."

The eastern American black walnut tree is found throughout areas with warmer climates in the Mid-Atlantic, Southeast, and Midwestern regions of the United States. Black walnuts typically fruit from September to October. The husk, usually 1.5–2.5 inches (3–7 cm) across, is green and rounded, covering a hard, bony, dark brown or black nut. The kernel is oily, sweet, and most important of all, edible. Black walnuts are earthy, slightly bitter and astringent, and are described as having a bold, nutty aroma and flavor.

"We first brewed our Black Walnut ale for a beer fest in the fall of 2011," says Brian. "Joleen wanted to brew a beer that featured black walnuts. The Ozarks are known for having an abundance of black walnut trees, and the nut grows wild and is hand harvested. She grew up harvesting black walnuts to eat and to sell to make a little folding money as a kid."

The earthy, nutty character of the walnuts seemed an ideal fit for some kind of darker, maltier beer, according to the Durhams. Brian made the decision to use a wheat base for the beer to allow the flavor and aroma of the nut to shine.

"We use dark malts that add more color than flavor in our dark wheat beers," says Brian. "Our favorite thing about dark wheat beers is that they can be really approachable and drinkable for people that say or think they don't typically like to drink dark beers. Dark wheat beers can drink a lot lighter than they appear."

The primary concern when brewing with any kind of nut is the oils, which can ruin a beer's head retention when added following primary fermentation. Nuts are high in unsaturated oils, which are metabolized by yeast, and can actually benefit the yeast during the initial phases of fermentation. (It's for this same reason that some brewers have experimented with adding olive oil to yeast starters in place of aeration.) When adding the nuts to the mash, as Piney River does, the oils should have no noticeable impact on head retention.

Still, many homebrewers are accustomed to adding such flavor-enhancing ingredients late in the process, during conditioning, where the strongest possible flavor can be extracted. For those who wish to continue experimenting with black walnuts — or any other kind of nut — there is one technique that should remove enough of the oils to enable a post-fermentation addition. Roasting the nuts (removed from their shells) at 250–300 °F (120–150 °C) helps to unlock their flavor, and afterwards, the nuts can be kept in paper bags overnight, which will soak up oil. Keep in mind: The more contact with the paper bags, the more oil will be soaked up, so try not to overstuff the bags. The next day, the nuts should be wiped down prior to adding to a secondary fermenter to further remove any excess oils. While there is still some risk of an impact to the beer's head retention, this method can enable a brewer to punch up the flavor for bigger, stronger beers.

"Interestingly enough, in the Black Walnut ale, the walnut almost takes on a fruity flavor," says Joleen. "The astringency disappears and the beer is very easy drinking with a unique flavor."

PINEY RIVER BREWING CO.'S BLACK WALNUT CLONE

(5 gallons/19 L, all-grain)
OG = 1.045 FG = 1.011
IBU = 15 SRM = 18 ABV = 5%

INGREDIENTS

6.2 lbs. (2.8 kg) white wheat malt
3.5 lbs. (1.5 kg) Munich malt
8.8 oz. (250 g) crystal malt (60 °L)
3.2 oz. (71 g) Carafa® Special III malt
3.5 lbs. (1.6 kg) black walnuts
3 AAU Hallertau hops (60 min.) (0.75 oz./22 g at 4% alpha acids)
Wyeast 1056 (American Ale), White Labs WLP001 (California Ale), or SafAle US-05 yeast
¾ cup corn sugar (if priming)

STEP BY STEP

If possible, use fresh cracked black walnuts for best results, though subbing in store-bought walnuts is another option. If using fresh walnuts, discard shells and collect 3.5 pounds (1.6 kg) of nuts. Bake the walnuts around 250–300 °F (120–150 °C) until lightly tanned. Use a paper towel to wipe away any excess oils.

Mash all the grains and walnuts in with 2.75 gallons (10.4 L) of 165 °F (74 °C) strike water to achieve a rest temperature of 152 °F (68 °C). Hold at this temperature for 60 minutes.

Sparge with water at 170 °F (77 °C) to collect about 6 gallons (23 L) of wort. At start of boil, add the hops and boil for 60 minutes.

Chill wort to slightly below fermentation temperature, around 66 °F (19 °C). Aerate wort if using a liquid yeast and then pitch yeast. Ferment around 68 °F (20 °C) for one week, then allow a week for settling. Keg and force carbonate or bottle and prime as usual.

PINEY RIVER BREWING CO.'S BLACK WALNUT CLONE

(5 gallons/19 L, extract with grains)
OG = 1.045 FG = 1.011
IBU = 15 SRM = 18 ABV = 5%

INGREDIENTS

4 lbs. (1.8 kg) wheat liquid malt extract
2 lbs. (0.9 kg) Munich dried malt extract
8.8 oz. (250 g) crystal malt (60 °L)
3.2 oz. (71 g) Carafa® Special III malt
3.5 lbs. (1.6 kg) black walnuts
3 AAU Hallertau hops (60 min.) (0.75 oz./22 g at 4% alpha acids)
Wyeast 1056 (American Ale), White Labs WLP001 (California Ale), or SafAle US-05 yeast
¾ cup corn sugar (if priming)

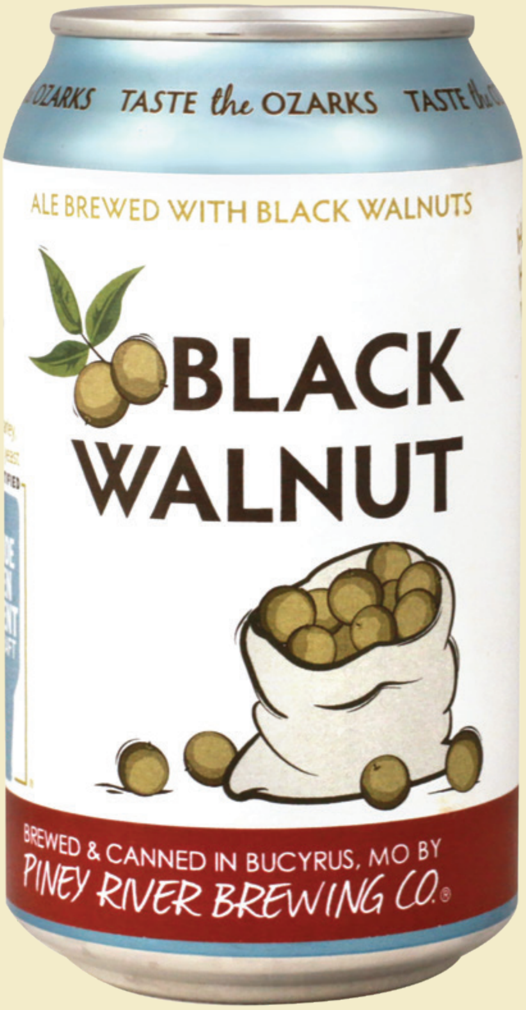
STEP BY STEP

If possible, use fresh cracked black walnuts for best results, though subbing in store-bought walnuts is another option. If using fresh walnuts, discard shells and collect 3.5 pounds (1.6 kg) of nuts. Bake the walnuts around 250–300 °F (120–150 °C) until lightly tanned. Use a paper towel to wipe away any excess oils.

Steep the specialty malts along with the nuts in a muslin bag in 2 gallons (8 L) of water at 152 °F (68 °C) for 15 minutes.

Remove the grain bag, place it in a colander, and wash with 1 gallon (4 L) of warm or hot water. Then add water to reach a total volume of 6 gallons (23 L). Bring liquid to a boil, then turn off heat and carefully stir in the liquid malt extract to dissolve completely. Return to a boil and add hops, then boil for 60 minutes.

Chill wort to slightly below fermentation temperature, around 66 °F (19 °C). Aerate wort if using a liquid yeast and then pitch yeast. Ferment around 68 °F (20 °C) for one week, then allow a week for settling. Keg and force carbonate or bottle and prime as usual. BYO



BY ASHTON LEWIS

A FRESH LOOK AT HOP CREEP

Plus: Hop utilization rates and a different approach to beer judging

Q I HAVE A QUESTION ABOUT SOME BEERS THAT SEEM REALLY DRY AFTER DRY HOPPING AND WONDER IF IT COULD BE CAUSED BY HOP CREEP. I HAVE READ A LITTLE ABOUT THIS PROBLEM AND THINK I MAY BE SEEING THIS AT HOME. THE ODD THING IS THAT IT DOES NOT HAPPEN ALL OF TIME, EVEN WHEN I BREW THE SAME BEER. ANY IDEAS?

STEVEN MALONE
LITTLE ROCK, ARKANSAS

These enzymatic changes can be problematic for beers during aging because an uptick in fermentation late in the process can lead to increased diacetyl in finished beer.

Photo by Grant Braddish

Certain enzymes in hops that survive kilning can cause "hop creep," a phenomenon of a beer fermenting to a lower final gravity than if it had not been dry hopped.

A Let me start this answer off with a brief review of hop creep. This term refers to dry hopped fermentations that slowly ferment to a lower final gravity than they would without the addition of dry hops. Because the process is slow, brewers call it hop creep. Back in 2016, the quality control crew at Allagash Brewing noted something off in one of the first beers they dry hopped when the beer over-attenuated after bottling. Allagash bottle conditions a lot of beer and have a very good idea of what typically occurs during bottle conditioning. Their experience coupled with excellent sleuthing led them to conclude that the root cause of their problem was something to do with hops. See my column from the January-February 2019 issue of *BYO* for more about the history of hop creep because Allagash and Bell's Brewery both stumbled on a problem first described in 1893 by Brown and Morris (read it online at www.byo.com/mr-wizard/hop-creep-explained).

Today, the community of brewers and scientists agrees that hop creep is most certainly caused by certain hop enzymes, especially starch debranching enzymes, that survive kilning. These debranching enzymes convert unfermentable dextrins found in beer into fermentable sugars. These enzymatic changes can be problematic for beers during aging because an uptick in fermentation late in the process can lead to increased diacetyl in finished beer. These changes can also be a problem in bottle-conditioned beers when beer carbonation goes above what is expected due to yeast fermenting sugars released from dextrins by hop enzymes. The latter problem can lead to bottle bombs where the former often leads to prolonged aging to wait out the reduction of diacetyl.

The head scratcher for me has always been "why now?" It's not like dry hopping is new. One of the answers to this question that has often been cited was hopping rate is to blame. In other words, dry hopped beers have always creeped a bit but not significantly until recently because today's hopping rates are so incredibly high. That was never a strong argument for me because enzymes do their thing independent of concentration, they just do things faster when enzyme concentration is high. More recently, the scientific community has demonstrated that hop kilning temperature is the likely cause. Anecdotal data also suggests that there may be a varietal link with hop creep. Regarding kiln temperature, Dr. Tom Shellhammer's group have shown that hops that cause hop creep in a lab setting do not cause hop creep when they are heat-treated prior to addition. And this root cause also makes sense in practice because many U.S. hop growers have slowly lowered hop kiln temperatures from about 155 °F (68 °C) to 125–135 °F (52–57 °C) over the last six years or so in response to requests by brewers to improve hop aroma quality. Brewers are now questioning if the lower kiln temperatures provide more headache than they do aroma improvement.

I think what you are likely observing in your homebrew is hop variability. That could be due to the same hop variety coming from different hop farms using different kiln cycles or even the same hop farm kilning hops slightly differently between lots. Whatever the source of variability in hops, what you have observed is not uncommon in commercial breweries; some beers creep and others don't. What's a brewer to do?

The most common remedy is to dry hop as usual, be that early or late in fermentation, and let the beer age until changes stop occurring. In practice, early dry hopping is a handy way to add dry hop aroma without extending the process. And if you don't want to age your beer on hops for too long, consider tying a string to your hop bag so that you can pull the hops out whenever you like. Two key parameters to track after dry hopping are beer gravity and diacetyl. I personally don't like over-sampling my homebrews because it wastes beer. Two samples spread apart over 5–10 days are sufficient to let you know if the gravity is steady. If it's not, keep waiting.

Diacetyl is something to check before cold crashing. Although the method is easy, it does require a special tool. And that is a well-trained and trusty sniffer. Most of us can be trained to detect diacetyl, but some of us simply cannot detect diacetyl, even at levels that most consider off the charts. If you cannot detect diacetyl in beer, find a family member or friend to be your surrogate. When it comes to testing time, take a small beer sample, cover with plastic wrap, hold the sample in a hot water bath at 140 °F (60 °C) for 20 minutes (this forces the conversion of diacetyl precursor to diacetyl), and smell. If you smell butter, keep aging. Be aware that this method can cause beers with certain special malts, like crystal types, to pick up oxidized malt flavors that may be confused with diacetyl and/or make diacetyl detection challenging.

Whether you keg your beers or bottle condition, cold crashing may be a part of your process. When you confirm that gravity is stable, and diacetyl is not a concern, cold crash your brew and package as usual.

Q I WAS RECENTLY READING AN ARTICLE FROM THE *BYO* ARCHIVES ABOUT RECIPE FORMULATION, AND THE PART ABOUT HOP PREDICTION LEAD ME TO A QUESTION: WHAT IS MEANT BY "BOIL EFFICIENCY"? THE HOP CALCULATION IN THE ARTICLE AND AN EXAMPLE CALCULATING ARE SHOWN BELOW.

$$\text{HOP WEIGHT (OUNCES)} = \frac{\text{(GALLONS WORT) X (IBU TARGET)}}{\text{(\% OF HOP BILL) X (\% ALPHA ACID) X (\% BOIL EFFICIENCY) X 7,490}}$$

FOR EXAMPLE:
5 = GALLONS WORT
60 = IBU TARGET
(100%) = % OF HOP BILL
0.05 (5%) = % ALPHA ACID
0.30 (30%) = % BOIL EFFICIENCY

$$\text{HOP WEIGHT (OUNCES)} = \frac{(5) \times (60)}{(1.00) \times (0.05) \times (0.30) \times 7{,}490} = 2.67 \text{ OUNCES}$$

THANK YOU FOR THE HELP!

GREG WILHELMI
BOONE, IOWA

A The term "boil efficiency" typically refers to "hop utilization" and relates hop alpha acids added to wort to iso-alpha acids in beer. I will use the standard term "hop utilization" in this answer to prevent any confusion with the term "boil efficiency" as that makes me think of other things like evaporation rate and heat transfer rate.

For starters, let's digest the basic definition of hop utilization and review why hop utilization has a practical maximum of about 40% for large commercial breweries and about 30% for homebrewers and most craft brewers. Hops contain alpha acids, among other hoppy components, useful to brewers. When hops are boiled, alpha acids contained in hop lupulin glands soften and dissolve into wort. It turns out that alpha acids have very limited solubility in aqueous solutions because they are hydrophobic (water fearing). Hydrophobic compounds tend to literally stick together in aqueous solutions and when they are less dense than the solution they float to the surface. Think of vegetable oil added to a pot of boiling water; the oil is visible as large, amorphous, balloon-looking blobs. When foam develops in a pot of boiling pasta, chicken stock, or wort, oils are carried with the foam and some of these oils are deposited on the surface of the pot above the liquid level. We see this when cleaning pots after boiling wort, pasta, and chicken stock. This relates to hop utilization because oil, aka alpha acid, loss is one reason why hop utilization is less than 100%.

Aside from getting hop acids to stay in wort and away from the surface of the kettle, another key of hop utilization is the conversion of hop alpha acids into iso-alpha acids. When alpha acids are heated above about 176 °F (80 °C), they begin to morph or isomerize into a different group of compounds named iso-alpha acids. Turns out there are several types of alpha acids and each type morphs into a specific iso-alpha acid. Chemistry aside, this transformation depends on temperature, time, pH, and wort density. As wort density increases, isomerization rate decreases (although iso-alpha acid solubility increases). And as temperature, time, and pH increase, so does the rate of isomerization. It's worth noting that while increasing wort pH increases isomerization and hop utilization, it also decreases the quality of bitterness, increases wort color, changes the way malt proteins precipitate, and has a negative effect on beer stability. Suffice to say, increasing wort pH is not something brewers do to increase hop utilization.

Because hop utilization compares hop alpha acids added to wort to iso-alpha acids in beer, wort boiling is just one part of the process where losses occur. Iso-alpha acids are more soluble and less hydrophobic than alpha acids, but they are still sticky and have limited solubility in wort (that's why the limit of beer bitterness is about 120 IBUs, regardless of marketing claims made on beer labels). Alpha and iso-alpha acids are also lost to trub, fermenter surfaces contacted by beer foam during fermentation, some beer finings, filtration surfaces, and anytime in the process when beer foams. One practical way to increase hop utilization is to use anti-foams during wort boiling and fermentation. But your question is not about how to increase hop utilization, just what it is.

The next question, how does a brewer know what value to use when calculating hop additions, is easy to answer but far from easy to assess. The easy answer is to compare iso-alpha acids in beer to hop alpha acids added to wort. Duh! However, most small-scale brewers, both home and craft breweries with limited production, don't know the iso-alpha acid content of their beers because the testing method requires special equipment, is time-consuming to perform, and uses a solvent that must be properly captured and disposed of after use. The other challenge is knowing how much hop alpha acids were added to the kettle.

Let's tackle this last point first. Because the hop alpha acid content is printed on all packages of hop pellets and hop cones, knowing how much was added seems simple. Right? The problem is that alpha acids oxidize during hop storage and the value printed on the bag changes over time. When hops are packaged and stored properly, the rate of alpha acid change is slow. Therefore, using the value on the package is not a bad place to start if we recognize what we are dealing with. And as luck would have it, alpha acids oxidize into a group of bitter compounds called humulinones. While humulinones are less bitter than iso-alpha acids, they do preserve some of the bitterness and do not represent a complete loss when hops oxidize. In practice, however, this poses a challenge because it means that hop storage plays a role in hop calculations. Let's just leave that idea and keep moving!

The real challenge in this whole thing is knowing the iso-alpha acid content of beer to develop prediction models. The homebrewing hop models developed by Rager, Tinseth, and Garetz in the early 1990s are all problematic because none of the methods make any mention of how utilization was measured. Please correct me if I am wrong, but I cannot find anything written by these authors documenting how they went about determining utilization. Not to cast shade because their efforts helped many brewers with hopping. The good news is that larger breweries do routinely measure iso-alpha acids in beer, and we know enough to be able to come up with some pretty safe assumptions.

Table 1, below, is a synthesis of utilization rates from several sources plus some massaging. It's important to know that any utilization rate from a table is some form of a guesstimate; without knowing what goes into the kettle and what ends up in the beer, we simply do not know what happened. This is why many brewers don't get too worked up over calculated IBUs. When calculations are performed consistently and adjustments are made based on perceived bitterness, the numbers are simply a means to an end. I hope this sheds a useful light on your question!

Table I: Hop Utilization Rates

Boil Duration (minutes)	Wort Density				
	1.040 SG	1.050 SG	1.060 SG	1.070 SG	1.080 SG
	10.0 °P	12.4 °P	14.7 °P	17.1 °P	19.3 °P
0	6%	5%	5%	4%	4%
10	14%	13%	13%	12%	11%
20	20%	19%	18%	17%	16%
30	24%	23%	21%	20%	19%
40	27%	25%	24%	22%	21%
50	29%	27%	25%	23%	22%
60	30%	28%	26%	24%	23%
70	31%	29%	27%	25%	23%
80	32%	29%	27%	25%	24%
90	32%	30%	28%	26%	24%

TAKEAWAYS FROM THE JAPAN BREWERS CUP — YOKOHAMA, JAPAN, FEBRUARY 9, 2024

Earlier this year, I had the great opportunity to travel to Japan to visit some breweries, give a presentation to a group of brewers gathered to judge beers at the Japan Brewers Cup in Yokohama, participate in the judging, and return the next day for the festival and award presentation ceremony. It's been many years since my past trip to Japan and I hope my next visit is sooner than later because Japan is a wonderful place to visit. One of the many highlights of my recent trip was participating in the Japan Brewers Cup judging process. Not only was the whole process very well run and the beers terrific, but the judging methodology was totally different from what I have seen in my previous judging experiences, opening my eyes to something new.

Homebrewing and commercial brewing competitions are largely based on beer style where serious consideration is given to how a beer entry conforms to category guidelines. Entering a great beer in the wrong category can result in a very low score. Similarly, a group of judges influenced by a vocal expert may place too much emphasis on splitting stylistic hairs. That excellent black beer entered as a porter does not medal because the judges ultimately determine that the beer was really a stout and unworthy of an award as a porter. My dear friend and brewing mentor, Dr. Michael Lewis, referred to taxonomists and definers of beer style as "splitters" because they split things into different cubbyholes for classification, and often recategorize the cubbyholes as new information comes along. Michael is a self-proclaimed "lumper" more interested in big picture ideas. The Japan Brewers Cup was a breath of fresh air for me because I, too, am a lumper and found the methodology used for this competition to be more aligned with how *Ashton the Beer Consumer and Brewer* evaluates beer versus *Ashton the Guest Homebrew Judge*.

Unlike the Great American Beer Festival with 99 categories representing 175 beer styles and up to three medals awarded per category, the Japan Brewers Cup had a total of just six categories with six awards per category. That's right, I said six total categories! And instead of coming up with a score for each beer, judges were tasked with ranking beers from top to bottom in each of several judging rounds. The six "lumpy" categories were wheat beer, lagers, ales, fruit beers, IPAs, and dark beers.

The judging sheets only required judges to rank the beers, but judges were told to consider aroma, flavor, finish, drinkability, and total quality when assessing each beer. Those five attributes were the real focus of the judging. We were also given the style, OG, and calculated IBUs of each beer along with any special notes. Although we were instructed not to judge beers based on conformity to style, we were told to consider the style as it related to certain flavor characteristics. For example, sourness in a wheat beer identified by the brewer as a funky saison may be just fine but that same character in a wheat beer identified as a hefeweizen should be considered a flaw.

What really stood out to me in this approach was the emphasis placed on drinkability and total quality. While these ideas are open to interpretation, they get right at the consumer experience. It's one thing for a beer to conform to style and have all sorts of interesting flavors and complex aromas, but if the beer is not highly drinkable and the consumer will not purchase it again some day, it's really doomed in the market. When I was judging and thought of these traits, I asked myself if I would drink an entire serving of the beer, and if I were in the mood for another beer, would I want to drink another of the same beer?

In a world largely defined by style, be it in clothing, food, music, or beer, the Japan Brewers Cup judging experience was a great reminder that all things do not need to be split into categories and qualified by type. When the first day of the festival began to wind down, it was award time. It was cool seeing the same excitement upon receiving an award for first place lager as I've witnessed for a gold medal in the German-style Pilsner category in style-based competitions. I need to go back to Yokohama next year to check back in on this festival! BYO

Photo by Ashton Lewis

In the Japan Brewers Cup, judging is done with beers entered into just six categories with emphasis on quality and drinkability instead of the style-based judging systems used in most North American beer competitions.

Photo by Ashton Lewis

Six commercial brewers receive medals in each of the six categories in the Japan Brewers Cup — a huge contrast to the three medals given in most of the 99 categories in the Great American Beer Festival.

BY GORDON STRONG

BRITISH BROWN ALE

An old style with a much more recent history

The most popular example was Newcastle Brown Ale . . . but Samuel Smiths also made a delicious Nut Brown Ale that was easy to find.

BRITISH BROWN ALE
BY THE NUMBERS

OG:	1.040–1.052
FG:	1.008–1.013
SRM:	12–22
IBU:	20–30
ABV:	4.2–5.9%

Photo by Charles A. Parker/Images Plus

English brown ale has a special place in my heart since it was one of the first styles that I discovered when I was learning about craft beer (so long ago, that it wasn't called craft beer) and was the first beer that I made as a homebrewer. When I became a judge, I often asked to not judge English brown ales because they were often the first beer a brewer made, and as such, were often problematic. I long for those days, as it is becoming increasingly difficult to find the style.

As a new beer geek, I learned that English brown ales came primarily in two varieties, northern and southern, and the northern English brown ale was the kind I liked best. The most popular example was Newcastle Brown Ale (Newcastle is indeed in the northeast of England, almost to Scotland), but Samuel Smiths also made a delicious Nut Brown Ale that was easy to find. I came to understand that nut brown ale was another name for northern English brown ale. Much later, I tasted a Mann's Brown Ale on a visit to the U.K. and found it very sweet and dark, almost like a small sweet stout. Certainly, these two brown ales were quite different.

But then the story got more complicated. I kept trying different brown ales, but they didn't always fit into these two categories. Things like Black Sheep Riggwelter, which was called a Yorkshire dark ale. The more examples I tried, especially while in England, seemed to be less like either of the two exemplars of style. Newcastle and Mann's seemed to be outliers, while a larger body of beers was generally ignored.

When the Beer Judge Certification Program (BJCP) reorganized the style guidelines in 2015, the northern English brown ale was expanded to include the larger range of brown ales, but the sweeter southern style was moved to the historical category and renamed as London brown ale, which reflects its roots. To show that these beers are not exclusively English, the more expansive British name is used, which also helps signal that the styles had changed between the 2008 and 2015 guidelines.

The BJCP currently categorizes British brown ale as Style 13B in the Brown British Beer category along with dark mild and English porter. These beers are not historically related, but they do have some similar flavors that makes them easy to judge together.

HISTORY

In *Amber, Gold, & Black,* English beer writer Martyn Cornell calls brown ale "one of the oldest styles of British beer." While that is almost certainly true (recall that Porter replaced brown beer in the London area starting around the 1720s — so, London brown beer was popular in the 1600s), what we think of today as British brown ale is not the same beer. Current British beers have their origin in 20th century United Kingdom, not in the 17th century Kingdom of Great Britain.

Brown beer was originally an urban beer that was the main style in London at the end of the 1600s. It's helpful to call it a beer at this time since it implies that it was a hopped style, not an unhopped (or lightly hopped) ale. It didn't exactly have a great reputation, so it was eventually displaced by porter (and later stout) in Britain and Ireland by the 1750s or so. While it was likely sent to colonies in America at the time, it became mostly a dead style in Britain until modern versions resurrected the name.

Around 1902, Mann's created a sweet, bottled brown ale of low alcohol in London. Nut brown ales started appearing around the 1920s in London with breweries such as Truman's, Whitbread, and Young's producing examples. Newcastle began production of a blended, bottled, tan-colored beer in 1927. Despite its light color, it was called Brown Ale. Other good examples followed, such as Vaux Double Maxim and Samuel Smith's Nut Brown Ale. While sometimes available on draft, these beers were mainly a bottled product. Stronger examples existed as double brown ales, but the style wasn't immune to reductions in gravity during WWII.

Brown ale in the U.K. declined along with other darker beers like mild in the 1960s. Beer writer Michael Jackson helped introduce the style to the U.S. (and the rest of the world), and it became a popular style made in microbreweries during the early craft era in the U.S. Some breweries made examples that paid homage to the U.K. style, while others began experimenting with a newer, hoppier version. Pete's Wicked Ale was one of the first of an American brown ale style, but was originally meant as an English brown ale, just with extra hops. It tasted great, and helped launch a style that today has examples such as Brooklyn Brown Ale. A good modern example of a U.S. beer brewed in the English style is Cigar City Maduro Brown Ale.

Ironically, many U.S. brown ales are lighter in hops, so are actually fairly close to U.K. examples, except often higher in alcohol. Hoppier and stronger brown ales in the U.S. are probably better described as brown IPAs. But the original English brown ales can still be found in bars and breweries where customers appreciate a range of styles.

SENSORY PROFILE

The name British brown ale gives some initial clues about what to expect. It should be a brown-ish beer (perhaps lighter, as light as a dark amber), and it should have a British ale character in its malt, hops, and yeast. The color is more typically a coppery brown with reddish highlights, with a low off-white to tan head. The beer should not be opaque, and it should have good clarity.

The malt expresses itself as a sweet, nutty, or toffee-like aroma,

BRITISH BROWN ALE

(5 gallons/19 L, all-grain)
OG = 1.046 FG = 1.009
IBU = 21 SRM = 18
ABV = 4.9%

INGREDIENTS

5 lbs. (2.3 kg) Maris Otter malt
2 lbs. (907 g) Golden Promise malt
1 lb. (454 g) Torrified wheat
1 lb. (454 g) U.K. Crystal malt (65 °L)
8 oz. (227 g) U.K. Crystal malt (45 °L)
4 oz. (113 g) chocolate malt
5 AAU Goldings hops (60 min.) (1 oz./28 g at 5% alpha acids)
2.5 AAU Goldings hops (10 min.) (0.5 oz/14 g at 5% alpha acids)
0.5 oz. (14 g) Goldings hops, 5% alpha acids (0 min.)
Wyeast 1318 (London Ale III), Omega Yeast Labs OYL-011 (British Ale V), or LalBrew Verdant IPA yeast
¾ cup corn sugar (for priming)

STEP BY STEP

This recipe uses reverse osmosis (RO) water. Adjust all brewing water to a pH of 5.5 using phosphoric acid. Add 1 tsp. of calcium chloride to the mash.

This recipe uses an infusion mash. Use enough water to have a moderately thick mash (1.5 qts./lb. or 3.1 L/kg). Mash in the pale malts at 151 °F (66 °C) and hold for 60 minutes. Add the crystal and chocolate malts, stir, begin recirculating, raise the mash temperature to 169 °F (76 °C), and recirculate for 15 minutes.

Sparge slowly and collect 6.5 gallons (24.5 L) of wort.

Boil the wort for 75 minutes, adding hops at the times indicated in the recipe.

Chill the wort to 68 °F (20 °C), pitch the yeast, and allow to ferment until complete.

Rack the beer, prime and bottle (or cask) condition, or keg and force carbonate.

BRITISH BROWN ALE

(5 gallons/19 L, extract with grains)
OG = 1.046 FG = 1.009
IBU = 21 SRM = 18
ABV = 4.9%

INGREDIENTS

5 lbs. (2.3 kg) Pale liquid malt extract
4 oz. (113 g) Carapils® malt
1 lb. (454 g) U.K. Crystal malt (65 °L)
8 oz. (227 g) U.K. Crystal malt (45 °L)
4 oz. (113 g) chocolate malt
5 AAU Goldings hops (60 min.) (1 oz./28 g at 5% alpha acids)
2.5 AAU Goldings hops (10 min.) (0.5 oz/14 g at 5% alpha acids)
0.5 oz. (14 g) Goldings hops, 5% alpha acids (0 min.)
Wyeast 1318 (London Ale III), Omega Yeast Labs OYL-011 (British Ale V), or LalBrew Verdant IPA yeast
¾ cup corn sugar (for priming)

STEP BY STEP

Use 6.5 gallons (24.5 L) of water in the brew kettle; heat to 158 °F (70 °C).

Steep the grains for 30 minutes. Remove and rinse. Turn off the heat. Add the malt extract and stir thoroughly to dissolve completely. You do not want to feel liquid extract at the bottom of the kettle when stirring with your spoon. Turn the heat back on and bring to a boil.

Boil the wort for 60 minutes, adding hops at the times indicated.

Chill the wort to 68 °F (20 °C), pitch the yeast, and allow to ferment until complete.

Rack the beer, prime and bottle (or cask) condition, or keg and force carbonate.

sometimes with light chocolate notes, and a supporting caramel quality. Light hops with a floral or earthy character may be present, as can fruity esters be supportive. Both hops and esters should be of lower intensity than the malt.

The flavor is similar to the aroma, with a gentle to moderate malt sweetness on the palate. The finish should be medium to dry, with medium to medium-low bitterness giving a balanced or slightly malty impression in the finish and aftertaste. The malt flavors tend to linger and have nutty, toasty, biscuity, toffee-like, or slightly chocolate-y qualities. Similar to the aroma, hops and esters are optional but supportive if present.

There is nothing really remarkable about the mouthfeel. This is a standard strength beer, so it shouldn't have noticeable alcohol warmth. It has a medium-light to medium body, not something heavy or chewy. And the carbonation is moderate to moderately high, enough to be refreshing as a bottled product, not a lower-carbonation product intended for draft consumption.

I think important qualities are drinkability and balanced flavors. It should not be watery or thin, but also should not be thick or viscous. Flavors should be balanced and nuanced, not aggressive or sharp. But it should have noticeable flavor and aroma. It should not have strongly roasted flavors, and I find chocolate flavors to be mild if present. A wide range of interpretations is possible, so judges should allow for interpretation by the brewer to produce something interesting.

BREWING INGREDIENTS AND METHODS

Traditional British ingredients and methods are appropriate for this style. British malts, hops, and yeast will produce good results, and brewing sugars and adjuncts should not be frowned upon. Not all British ingredients are readily available to American homebrewers, so some substitution can give similar results as long as proper care is given to their use.

British pale ale base malt is common, although the more dextrinous and highly kilned mild malt is a favorite of mine. Blending base malts can give good flavor results as well. Using a British Maris Otter malt will give a bready and biscuity base, although I'll happily use Golden Promise as well. If mild malt isn't available, I'll often mix a pale ale malt with a Vienna malt to approximate it.

Flaked maize or torrified wheat can be used as starchy adjuncts (up to 10% of the grist). Other flaked grains like wheat or oats could be used in light amounts for body. I tend to avoid amber and brown malts as they can often provide too much of a drying, heavily toasted flavor; this is a personal preference, however. When I have made brown ales using brown malt, they tend to taste too porter-like to me.

I see crystal malts and brewing sugars to be somewhat equivalent in that they are used to provide flavor and color. Darker malts are unusual in higher concentration, although I have found a light amount of chocolate malt gives a nutty flavor without getting too chocolate-y. As this is a 20th century beer, crystal malts are appropriate to use, but darker invert brewing sugars could also be included. Darker malts can be used to adjust color, including ruby highlights, but I don't find they are necessary. I worry about their flavor contributions, as well as drying effects on the finish.

Hopping should be at a low enough level that there isn't a major flavor impact, so virtually any varieties can be used. I would avoid citrusy or too trendy a hop, and go with traditional English varieties. Fuggle and Goldings are usually my choice, as they can provide earthy and floral flavors. I would use a bittering addition, and possibly a small flavor/aroma addition. The bitterness level depends somewhat on the flavor profile and the residual sweetness (final gravity) of the beer. More flavor and sweetness can support more bitterness; the perceived bitterness and balance is most important, and that's hard to express as a single number.

Yeast, likewise, should be English in character. Fruity or malty ale strains would be more preferable than minerally or dry ones. Clean or lightly fruity American strains can be used, but the character malts would have to supply some additional fruity notes. Average to slightly warm fermentation temperatures can be used, but not so high as to start producing off-flavors. I often use the Fuller's or Young's strains (Wyeast 1968 or Wyeast 1318), but many choices are possible.

Brown ales typically don't rely on water to influence character, although I would avoid water with high sulfates. If adding calcium salts, I would prefer calcium chloride to give the beer a rounder, sweeter, wetter malty balance and finish. A single infusion mash is traditionally British, and the conversion temperature can vary. I tend to prefer to mash around 151 °F (66 °C) to give the beer some dryness, but I also tend to use dextrinous base grains and crystal malts, which will give the beer some residual sweetness anyway.

HOMEBREW EXAMPLE

I'm providing a relatively straightforward example using mostly British ingredients. The base malt is a mix of Maris Otter and Golden Promise, two of my favorite malts. I'm cutting the Maris Otter because I don't want the beer to be too biscuity, but it's certainly possible to use a more generic English pale ale malt. Torrified wheat provides some of the character flavor and a little body. Mid-range crystal malts provide some caramel flavors, and the light dose of chocolate malt gives enough of the nutty flavor without tasting overtly chocolate-like. I prefer to use English maltsters for the crystal and chocolate malt. A single infusion mash is very British, so I've used that approach.

The hops are almost an afterthought, but I'll still go quality and use Goldings. Balancing the malt with a light bitterness is all I'm really after, but a light late hop character is pleasant as well. The yeast is a traditional malty English ale choice. Anything that doesn't dry out too much is fine, and a lightly estery yeast is also a reasonable choice.

I've balanced the beer to be a little large for an English ale, which reflects the beer's heritage as mostly a bottled product. I keep the IBUs on the low side since I think the beer should have a malty-to-even balance, but that's my personal drinking preference. The color should come out a dark copper to light brown, but still not opaque. I like being able to see the clarity in this style. I hope you enjoy it as much as I did when I first discovered this style. BYO

FATHER'S DAY GIFT GUIDE

Reminder time . . . Sunday, June 16th is Father's Day. What better way to honor your favorite man, father, husband, partner, or friend than with one of these fine homebrewing products? Nothing says "I Love You" to a homebrewer quite like a gift of a fine new piece of equipment or beer-related goodie. And if you are the dad looking for homebrew gifts, try leaving these pages open with a big circle around the items you want. Don't leave them guessing — unless you want another World's Best Dad coffee mug.

Easy-Drinking Fermented Beverages

Make your own tepache, ginger beer, and kefir soda

by Trent Musho

Bacteria is often a dirty word in both the food and beer worlds. Bacteria spoil beer and food, and are responsible for a wide range of illnesses in food. However, good bacteria provide great benefits to both worlds by turning otherwise ordinary foods and beers into magical ones. *Lactobacillus* is one such bacteria, and it powers the fermentation in a lot of the fermented foods we enjoy. As homebrewers, we can use *Lactobacillus* as another tool in our kit to make some amazing drinks. So I pulled together three fermented drinks that use *Lactobacillus* to transform everyday grocery items into phenomenal low-ABV beverages, all with a fizzy finish!

Photo by Charles A. Parker/Images Plus

TEPACHE

Tepache was one of the first videos I made on my home fermentation YouTube channel, *TheBruSho*, and since I hit the publish button it has consistently been one of the most watched videos each month. That speaks to the interest and excitement that surrounds this fermented drink. Tepache has a relatively low ABV, usually under 2% depending on fermentation time. And best of all it's a dead-simple drink to make. It all starts with a pineapple, and with the addition of some sugar, spice, and water you've got all of the ingredients you need.

Tepache originally hails from the pre-Columbian Nahua people of Mexico. Their version used corn, but over time it adapted to include the succulent juice of pineapple. These days it's more of a street cart beverage enjoyed by locals looking for a refreshing thirst quencher.

What really makes tepache taste so good is the transformation through fermentation, all powered through natural bacteria found on the skin of the pineapple. In fact, all you really need from the pineapple are the skins (and feel free to add the core, too), which makes this a zero-waste fermentation project. If you are buying a whole pineapple to eat, then why not make this with the leftover bits?

The skins not only add the *Lactobacillus,* but the main flavor and a lot of the sugars needed for fermentation. Although additional sugars are also typically added in the form of piloncillo, a dense, dark-brown sugar often shaped into a cone-like form that you can find at any Mexican or Latin grocery store. Piloncillo has a rich and robust flavor with notes of molasses, toffee, and caramel that make it much more interesting than plain brown sugar, although that can be used in a pinch.

The last thing you need is cinnamon. I prefer the taste of cinnamon sticks, but powdered cinnamon works as well. This adds a beautiful warm note to the finished drink, giving it some complexity.

To make tepache, add into a fermenter the skins of one pineapple, one 8-oz. (225-g) piloncillo cone, and one or two cinnamon sticks. Top with water, up to one gallon (3.8 L). Cover with a loose lid, napkin and rubber band, or an airlock. Let it ferment on your counter out of direct sunlight for three to five days, tasting as it goes. You can tweak the final product to your taste. If you like it sweeter, ferment it on the shorter end, and if you like it funkier, ferment it longer. However, since we're not strictly focused on alcohol production, you don't want to fully ferment this out until it's dry, you'll need some sugars left behind for the next step.

Once it's to your liking, bottle it in fermentation-grade bottles. I like to use plastic PET bottles as I can better judge how carbonated they are, but glass swing top bottles also work great. It can just be tougher to judge their carbonation level in glass and it might be necessary to "burp" or open and reseal the bottles quickly to release pressure. This can help prevent bottle bombs and it could be needed every few days if you have a lot of residual sugars left. Speaking of which, no need to add more sugars like you would to prime a bottle-conditioned beer. There should be plenty of sugars left in this to continue fermenting in the bottle and create carbonation. Set the bottles on the counter for another week or so. The time it takes to carbonate depends on how long you let it originally ferment. Shorter fermentations will mean more sugars are still available and in that case carbonation will build faster.

Once they are carbonated to your liking, pop the bottles in the fridge overnight and enjoy. Alcohol content on tepache can range from 1–3% de-

Photo by Charles A. Parker/Images Plus

Tepache is a popular street vendor drink in Mexico made from pineapple skins, piloncillo sugar, cinnamon, and water. Depending on the length of fermentation, it can finish on the sweet side or more tart from the Lactobacillus *fermentation.*

pending on your total fermentation time and amount of sugar fermented.

Tepache should be quite carbonated and sweet with a hint of warm spice character. If you let it ferment on the longer end of the 3–5 day range, that sour and slightly funky *Lactobacillus* flavor is very delightful.

One of my favorite things to do with tepache is mix it half and half with a crisp Mexican lager. I have found no better way to cool off on a hot day than sitting poolside with a cool glass of this.

GINGER BEER

Ginger beer sounds like it would be a beer with lots of ginger, but this is actually a bit more like a ginger soda. Not to be confused with ginger ale, ginger beer is actually fermented, usually it's under 1% ABV (though there are versions with more beer-like alcohol levels), and has a strong spice kick. While ginger beer isn't something I'd drink by itself regularly, it is one of the best cocktail mixers you can make from home. Plus, it can be adapted to make a myriad of other fermented sodas thanks to the base fermentation that fuels this drink, called a "ginger bug." Don't worry, this is not actually an insect!

Ginger bug is to ginger beer as a sourdough starter is to sourdough bread. It's basically a smaller, more condensed fermentation that allows you to propagate enough bacteria to ferment larger batches. All you need to make a ginger bug is fresh ginger, sugar, and water.

The ginger provides a strong spice flavor as well as the *Lactobacillus* and yeast needed for the fermentation. Toss about 10 grams of chopped ginger into a Mason jar with 10 grams sugar and 1 cup water. As this sits on your counter, the *Lactobacillus* and yeast on the ginger will start to consume that sugar, slowly reproducing. For the next week, you'll feed this ginger bug more sugar and more ginger, 10 grams of each every day. After a few days you should start to notice more activity and eventually it should start to foam up a bit. That's when you know you're ready to make ginger beer.

Photo courtesy of Shutterstock.com

A homemade ginger bug is made from ginger, water, and sugar. The ginger bug is needed to propagate enough bacteria to ferment larger batches of ginger beer.

Photo by Charles A. Parker/Images Plus

Ginger beer can be drank on its own if you really love the taste of ginger, but it's also a tremendous addition to cocktails, including Moscow mules.

In a pot, heat 4 cups of water to a boil. Kill the heat and add in 30 grams of chopped ginger, skins and all, and 100 grams of sugar. This recipe makes a very sweet ginger beer. If you want it less sweet you can always dial back the sugar amount to your preference. For this entire process you can use any type of sugar. Table (cane) sugar, brown sugar, agave sugar/nectar, or whatever floats your boat. After the ginger-sugar water has steeped for 5 minutes, cool it down to room temperature and add in about 50 mL of your strained ginger bug liquid.

Instead of fermenting this again in a big fermenter, just add this ginger solution into some fermentation-grade bottles and seal them up. I recommend using PET bottles so you can better judge how carbonated they are getting. Otherwise, if using glass be sure to burp them every other day so you don't have any exploding bottles on your hands. Let them ferment on your counter for 3–5 days until they get nice and bubbly. Toss them in the fridge overnight and just like that you have ginger beer!

As I mentioned, you can use that little ginger bug to make all kinds of other fermented sodas as well. Take any sugary substance you want and add some ginger bug into it. Then bottle it up and in a few days you'll have a fizzy version of that drink. On my YouTube channel I've used ginger bug to make fermented root beer, sparkling lemonade, and all kinds of other fun drinks. Get creative and give it a go!

The most common way ginger beer is used is to make a Moscow mule (consisting of vodka, ginger beer, and lime juice).

Here is a unique twist on the classic cocktail that is a real crowd pleaser with guests:

APPLE CIDER MOSCOW MULE:

(Servings: 1)
4 oz. (120 mL) non-alcoholic apple cider
1.5 oz. (45 mL) vodka
Juice of 1/4 lime
Top up to 12 oz. (350 mL) with ginger beer

KEFIR SODA

You've likely seen a form of kefir while strolling the dairy section of your grocery store. Milk kefir is a popular probiotic drink, much like a drinkable yogurt, that people consume to support gut health. But lately, water kefir has become increasingly popular. While they both claim to help with digestion, weight management, and immune defense, water kefir is more like a health soda than a yogurt.

Both forms of kefir start with kefir grains, which are tiny crystals of bacteria and yeast. Much like a ginger bug, these can be added to a sugary drink to create fermentation, and thus probiotics and eventually carbonation. However, unlike a ginger bug, you can't grow these on your own, you'll need to purchase kefir grains to get started, unless you know someone who will give you some of theirs. With care, you should be able to grow and make endless batches with just one packet of grains.

Depending on which form of kefir you are making, you'll need to acquire the right version of grains before beginning as the milk and water versions are not easily interchangeable. I prefer the water kefir grains because they offer the opportunity to do the most experimenting and turn almost anything into a soda. You can easily find these starter grains online or even at some specialty health stores.

With the grains in hand, it's time to bring them to life. In their dry state they are inactive, so heat up 4 cups of water and mix in 1/4 cup sugar to dissolve. Allow that to cool to room tem-

Photo by Charles A. Parker/Images Plus

Kefir soda relies on kefir grains, small crystals of bacteria and yeast, for fermentation. Once hydrated, kefir grains can be used to ferment any juice that contains sugar into a low-ABV carbonated beverage.

perature, add in the kefir grains, and cover for 2–3 days. As they rehydrate, the grains will turn from a sandy, almost brown sugar color to near white. And you should see some bubbles and foam start to appear as the grains begin their fermentation journey.

Once fully hydrated, strain the water away from the hydrated grains and place them in a Mason jar. From here you can get as creative as you want. An easy method is to find your favorite juice and add it to this Mason jar on top of the kefir grains. The grains will ferment the sugars in the juice extremely fast and turn it into a probiotic version of the juice in just 24 hours. This process does produce a small bit of alcohol, usually between 0.5–2% depending on how much sugars are fermented. If you want it fizzy, you just need to strain out the grains and bottle up the fermented juice. Add a splash of that same juice to give some additional sugars and close it up. Let it ferment again in the bottle for a day or two and throw it in the fridge. Again, I recommend plastic bottles for safety and ease of determining how carbonated the beverage inside has become.

From there you just need to rinse the grains with some water and start over with some new juice. Rinsing the grains allows you you start on a clean slate with no carry-over of flavor, though isn't required. Since it does ferment so fast you can always take a break while preserving the grains by making a batch of plain sugar water at the same ratio as before (1/4 cup sugar to 4 cups water) and adding your grains to that. Then store it with a loose-fitted lid in your fridge for up to a month, any longer than that and you might need to refresh the sugar water to help keep the kefir grains alive and fermenting. As long as the grains have some sugars to munch on you should be able to keep this going for years.

Good options for flavor that I've enjoyed are to use coconut water, fresh fruit juice, or even just make it plain with sugar water and then add flavoring right to your glass. Adding some herbs can amplify the flavor to something even more delicious. Some of my favorite flavor combinations have included passionfruit-orange-guava, watermelon-mint, piña colada (pineapple and coconut water), hibiscus-ginger, lime-agave (sub out sugar for agave), and blueberry-lavender kefir soda.

READY TO GIVE IT A TRY?

Whether you're looking for inspiration, or just love experimenting, the world of low-ABV fermented beverages presents a spectrum of flavors, histories, and possibilities. Homebrewers can and should embrace *Lactobacillus* for its ability to turn ordinary ingredients into extraordinary, fizzy drinks. Not every batch will be perfect, and that's part of the joy of fermenting and experimenting with ingredients. But hopefully now you can take a step to try something new. BYO

Pilsners OF THE WORLD

How new-age Pilsners diverge from their contemporaries

by Gordon Strong

Pilsner is both a well-understood and poorly understood beer style. Craft beer enthusiasts know the origin story of the first pale lager brewed in 1842 in the Czech city of Pilsen (*Plzeň* in the Czech language). Casual beer drinkers may think Pilsner is another name for beer, since it is freely used on many light lagers (Miller Lite proudly says that it is "a fine Pilsner beer," for instance). Adding to the confusion is that the terms "lager" and "Pilsner" are used interchangeably at times.

Most Americans and craft beer enthusiasts think of lagers as a type of beer fermented with bottom-fermenting yeast. Most Europeans think of lagers as a type of beer fermented and conditioned at cold temperatures. Both are correct usages, so it is best to understand the context and where the terms are used since the actual definitions differ. In this article, I use lager to mean a beer fermented with bottom-fermenting yeast at cool temperatures and then cold conditioned for a period of time.

Pilsner (which also can be written as Pilsener) is a type of pale lager that originated in Pilsen – the name literally means, "from Pilsen." Within the Czech Republic, Pilsner is considered an appellation of origin, so only beers produced in Pilsen can be called Pilsners. This is why the Beer Judge Certification Program (BJCP) terms these beers "Czech premium pale lagers," which mirrors the Czech name *světlý ležák* (pale lager). Outside of the Czech Republic, these beers are sometimes called Czech Pilsners or Bohemian Pilsners (Bohemia is a region within the Czech Republic).

For purposes of discussing current beer styles, I often refer to Pilsner in the generic sense as a family of beers, including many that are not of Czech origin. It's easier to write this way, but please consider this to mean Pilsner-type beer since I believe the Czechs deserve to protect their heritage. From this point forward, I will use Pilsner to mean the family of styles and will add a qualifier when I am talking about a specific style.

MEET THE PILSNER FAMILY

As a family of beer styles, Pilsners have common elements. The most important is that they are pale lager beers with noticeable hop character and bitterness. They are clear beers, no darker than golden in color, with a well-developed white head. They tend to be average strength beers (around 5% ABV with starting gravities around 1.048 or 12 °P). I usually think of Pilsners as having at least 20–25 IBUs in bitterness so as to separate them from the more common *lager* family of beers (not the broad category of lagers, but the collection of lower-bitterness, mass-marketed pale lagers — the BJCP calls these styles International pale lagers, American lagers, and American light lagers). Regardless of how they are branded, I don't consider these beers to be true Pilsners due to their low bitterness.

Czech Pilsner (Bohemian Pilsner, Czech Premium Pale Lager, BJCP style 3B) is the original Pilsner style, made famous by what was later branded Pilsner Urquell. Compared to other Pilsners, these are maltier, richer, darker in color, and have more body. Czech beers in general have greater residual extract (higher finishing gravity) so they tend to have more of a malty finish and greater mouthfeel. They are characterized by a strong bitterness and traditionally feature Saaz hop aroma and flavor. Low-mineral water used in brewing allows for a higher level of hopping without harshness. Decoction mashing is common, with

Pilsner Urquell using a triple decoction mash. Czech yeast and brewing techniques can leave a trace level of diacetyl in the beer, but this character should not be prominent.

German Pils (German Pilsner, BJCP style 5D) is derived from Czech Pilsner, and adapted to local brewing conditions. Compared to Czech Pilsner, it has a lighter body, a drier finish, and is lighter in color. It can have a sharper finish as some German water is higher in sulfates. German hop varieties are commonly used with noble-type hops being traditional. Step mashing is often used for producing the beer. Regional variations exist in Germany (as with bitters in the U.K.), with drier examples found in the north and maltier examples in the south.

American Pilsner (Pre-Prohibition Lager, BJCP Style 27) is derived from Czech Pilsner and German Pilsner, having come to the United States with immigration in the late 1800s. The ancestor to modern American lagers, this beer was balanced more like Czech Pilsner but made with American ingredients. Traditionally, 6-row malt with corn or rice as adjuncts was used, with native American hops used for bittering and imported European hops for aroma and flavor. Few examples exist today of this historical style, although it has inspired modern craft variations. After Prohibition ended, American Pilsner became more industrialized and increasingly bland and less bitter, so it essentially morphed into modern American lager.

Other European countries began making Pilsners in the style of German Pils, but adapting to their own markets. These tended to be less bitter, and they could be made with adjuncts. While they may be called Pilsners in their local markets, they are essentially described by the International Pale Lager style (BJCP style 2A). Distinct examples exist in Belgium, France, the Netherlands, Scandinavia, Poland, and elsewhere. While these examples may use local hop varieties, they are generally not hopped sufficiently to be recognizable as modern Pilsners. Many of these are premium mass-market beers of high quality,

Photo by Charles A. Parker/Images Plus

but generally have less bitterness than other Pilsner examples.

Entering the modern craft era, German Pilsner has served as the inspiration for a huge variety of modern examples. While Czech Pilsner is the undisputed original, it is the German Pilsner with its drier, crisper finish and more streamlined recipe and production method that is most often chosen as the template for variation and experimentation. While German and Czech Pilsners are not traditionally dry-hopped, many modern variations use this technique, as well as generally increasing the late hop profile.

I think there is actually a major variation of German Pilsners that involve dry hopping. Let's call these **hoppy Pilsners** (best to enter currently as BJCP style 34B Mixed-Style Beer), although few are branded as such. With a change in hop varieties, I've seen these beers called **Italian Pilsner** (when using noble-type hops), **West Coast Pilsner** (when using American IPA-type hops), and **New Zealand Pilsner** (when using New Zealand hops; note, though, the Kiwis define New Zealand Pilsner differently). If you accept the general idea of hoppy Pilsner, then you can see how easy it is to extend the variations when additional hop varieties (possibly using hops not yet released) are used. Some brewers may use American Pilsner to mean something similar to West Coast Pilsner, rather than as a historical term.

These variations often make changes in base malt and water chemistry from the German Pilsner, not just varying hop varieties. However, they all do tend to use a similar neutral lager yeast, preferably ones that are low sulfur producers. In general, when increasing possibly sulfury hops, the sulfur content of the water should be lowered, which can often produce a softer finish. When the overall sulfur load in the beer becomes too high, the beer can seem increasingly objectionable, regardless of the source of the sulfur.

I find the currently popular **West Coast Pilsner** to be a curious notion. Brewers can make it in different ways, including using corn and rice as adjuncts. Some may use a warmer fermentation to attempt to reduce the sulfur content (which is what often made so-called India pale lagers, or IPLs, less popular). But an average strength lager made with IPA hops and possibly adjuncts sounds awfully familiar. Cold IPA, perhaps? Regardless, the resulting beers are quite enjoyable.

In New Zealand, they do have a local style they call **New Zealand Pilsner** (BJCP style X5). However, it is different from the style that many American craft brewers (and judges) seem to want to call that style. The base beer isn't exactly like a German Pilsner; it is in between German and Czech examples in that it has a maltier, softer finish. But it doesn't have the richer malt flavors often found in Czech examples. The most unusual aspect is that many New Zealand brewers produce this as a cool-fermented ale, not a lager. They could use a dry yeast like SafAle US-05 to make the beer, or the more traditional SafLager W-34/70. Commercial producers might use the faster ale yeast, while homebrewers prefer the traditional lager yeast. Either way, the beer tends to have a neutral fermentation profile.

In Germany, there is another traditional style worth mentioning. Kellerbier is a traditional family of lager beer using a more rustic conditioning and serving method, resulting in beers with a greater yeast character. While not traditionally applied to Pilsners, in the modern craft era the technique has been used this way to create what is sometimes called the **Keller Pils** (BJCP style 27). This type of beer does not have to be as clear, can have more body, and usually has greater fresh yeast flavor (including higher levels of fermentation byproducts typically reduced during long cold conditioning). This style is not limited to Germany, as craft brewers worldwide are producing it.

Germans and Czechs produce Pilsners (and other lagers) of differing strengths, often considering these to be separate styles. In Germany, a lower-alcohol Pilsner can be called a **Leichtbier** (BJCP style 5A), although that term can also be applied to a helles-type beer. Czechs typically include the degrees Plato in the beer description, and lower alcohol Czech Pilsners are categorized as **Czech pale lagers** (BJCP style 3A, *světlé výčepní pivo*).

As the Pilsner family continues to expand, there is also innovation in the lager family. Recently, styles such as Mexican lager and Japanese rice lager have become popular as craft beer styles in the U.S. and elsewhere. Lager could experience a similar treatment as Pilsner. For example, in Brazil I've seen dry hopping and increased late hopping applied to American-type lager to create something they call *hop lager*. I think techniques and experimentation seen in Pilsners are likely to continue in lagers as well, and vice versa. The craft era has broken many of the traditional beer style boundaries we once believed in, so for those who follow beer styles, try to have some flexibility in thought as brewers continue to experiment.

BREWING VARIABLES

When brewing Pilsners, there are a few key choices the brewer can use to control the finished beers. While there is some similarity between styles, there is a surprising number of alternatives in how to approach individual styles. I think the important variables include the base malt choice, whether or not to use adjuncts, the mash program, the water chemistry, the hopping, and the yeast selection.

Wait, Gordon, that's just about every part of beer. Yeah, pretty much. But there are some constraints to these choices that make it easier.

Regarding base malt, it kind of goes without saying that Pilsner malt is the most common choice. However, there are significant differences between Pilsner malt from different countries and between individual maltsters. The type of Pilsner malt can also influence the mash program. For instance, German Pilsners should be made from mostly German Pilsner malt, and the Germans traditionally use a step mash. Czechs can use a wide range of malts, from the same German Pilsner malt to Czech undermodified malt, which needs a more intensive mash program such as decoction. Some of these German and Czech malts are available as floor malted, different barley varieties can be used, and some are more highly kilned than others. I find some modern boutique Pilsner malts have too heavy a toasted flavor to taste good in a Pilsner, but that's my opinion. I find some Belgian Pilsner malts to have a slight fruitiness to them. The important point is that not all Pilsner malts taste the same, so it's best to understand the flavor profile from the ingredients you use.

Some American-style Pilsners and the lagers derived from them can be made with North American (U.S. or Canadian) Pilsner malt, lager malt, or 2-row brewer's malt. These tend to have less flavor intensity, especially bready flavors, than the European malts. Sometimes, I will dilute European Pilsner malts with North American malts to reduce the stronger flavors that might not be wanted in all variations. Some of the American Pilsner styles can use corn or rice, but the brewer has the choice of the form. Flaked versions are easier to mash, but can have less flavor. The unprocessed grains normally have to be cooked using a cereal cooker or double mash program, so few homebrewers go this route. American styles using adjuncts may be made using an infusion mash as well, for simplicity.

The mash program isn't just about converting starches to sugars; it also is how the brewer can control attenuation and how the beer finishes. The dry finish associated with German Pilsners is normally created by a step mash, although some brewers might use a single infusion mash with added dextrinous malts to not remove all the body. Czech lagers are normally at least double decocted to increase color, flavor, and mouthfeel associated with the beer.

German Pilsners often have calcium sulfate in the water to increase the dryness and sharpness in the finish. Just keep in mind that the added sulfur can cause some late hops to taste or smell unpleasant. Pilsners with a softer finish will use more calcium chloride, while Czech Pilsners are traditionally made with low-mineral water. Adjusting the water chemistry does more than facilitate the mash, keep in mind that it will have impacts on the finish of the beer and the interaction with the late hops.

Pilsners can benefit from high-alpha, but non-harsh, bittering hops. Something like Magnum is often used in German-style beers, but can certainly be used in any Pilsner style. The late hops drive the character of many Pilsners, and is what differentiates most modern Pilsners. Noble hops for German and Italian Pilsners, American or New World hops for West Coast Pilsners, and Czech Saaz hops for Czech Pilsners are common. The IPA-like Pilsners obviously have more choices, but remember to be aware of sulfury hops (like ones that have an oniony, dank, diesel-like, or other similar pungent character) that can clash with the water and yeast. Hoppy Pilsners can be made from other styles by replacing the bittering hops with first wort hops to increase the hop flavor while providing bitterness, and the flavor and aroma hops can be moved to the whirlpool or dry hop to increase the aroma.

Most Pilsners can be made with an attenuative, clean German lager yeast such as W-34/70. I've also had good luck with Mexican lager yeast, which is also clean and attenuative. Some lager yeast strains are known for producing additional fermentation byproducts that can enhance the flavor. If you have a hoppy beer, be sure you think about the interaction between yeast and hops flavors to have something compatible. Malty or less attenuative lager strains can be flavorful, but often have difficulty achieving the right finish in a Pilsner. I prefer to avoid lager strains that are known to be high sulfur producers, since I don't want too much of this character in my finished beers. Don't forget to lager the beer when fermentation is done; this step is critical to the smooth palate and clean flavors.

FINAL THOUGHTS

I often wonder what the original brewers of Pilsner in Pilsen would think of today's pale lager landscape. Would they recognize their beer in so many forms? Would they feel honored or offended by how pale lagers became simplified to appeal to the wider beer market worldwide?

If you are discussing Pilsners with people, keep an open mind about how they are described. Those with different frames of reference or background may be using the term in a less precise way. I will often use those conversations to understand what the drinker really enjoys about the beer they are drinking, since that might lead to other choices for them to try.

Lager and Pilsner have become overloaded words that have multiple meanings. I normally expect Pilsners to be more bitter and sometimes more hoppy than beers simply called lager (without any adjectives or modifiers), but I do expect them all to be pale. I expect both to have a smooth palate and to be refreshingly drinkable. I will make that first separation by examining the balance, particularly the bitterness level. If you are talking to more novice drinkers, that's not a bad place to start. If they like what they are tasting, feel free to pull out your beer passport and start showing them the Pilsners of the world. It's an enjoyable trip, and I hope to see you there.

RECIPES

I've included three Pilsner variations on the following pages. The German Pilsner recipe can be used as a template for any hoppy Pilsner. Replace bittering hops with a first wort hop addition of a flavor hop, move flavor and aroma hops to the whirlpool or dry hopping, and alter the variety of hops to match the target profile for the style.

The Pre-Prohibition Lager recipe can be a template for any adjunct Pilsner. For a throwback version, use 6-row lager malt and Cluster hops for bittering. Using IPA-like hopping with the beer can be used as a starting point for a West Coast Pilsner (or cold IPA).

The New Zealand Pilsner recipe can be a template for a Pilsner using a mixed grain bill to reduce the flavor of Pilsner malts. If you want to make it like some Kiwis do, substitute US-05 for the yeast. With all the variation in New Zealand hops today, feel free to experiment. Just keep in mind that New Zealand brewers almost never use Nelson Sauvin™ hops alone; they have too strong a flavor.

Pilsner Recipes

German Pilsner

(5 gallons/19 L, all-grain)
OG = 1.046 FG = 1.008
IBU = 29 SRM = 3.5 ABV = 5%

INGREDIENTS

9.25 lbs. (4.2 kg) Pilsner malt
6 oz. (170 g) CaraFoam® malt
7 AAU Magnum hops (60 min.)
  (0.5 oz./14 g at 14% alpha acids)
2 AAU Hallertauer hops (15 min.)
  (0.5 oz./14 g at 4% alpha acids)
0.5 oz. (14 g) Hallertauer hops (0 min.)
Wyeast 2124 (Bohemian Lager), White Labs WLP830
  (German Lager), or SafLager W-34/70 yeast
⅞ cup corn sugar (if priming)

STEP BY STEP

This recipe uses reverse osmosis (RO) water. Adjust all brewing water to a pH of 5.5 using phosphoric acid. Add 0.25 tsp. of calcium chloride and 0.5 tsp. of calcium sulfate to the mash.

This recipe uses a step mash. Use enough water to have a moderately thick mash (1.5 qts./lb. or 3.1 L/kg). Mash in the malts at 131 °F (55 °C) and hold for 10 minutes. Raise the temperature to 145 °F (63 °C) and hold for 40 minutes. Raise the temperature to 158 °F (70 °C) and hold for 10 minutes. Begin recirculating, raise the mash temperature to 169 °F (76 °C), and recirculate for 15 minutes.

Sparge slowly and collect 6.5 gallons (24.5 L) of wort. Boil the wort for 90 minutes, adding hops at the times indicated in the recipe. Chill the wort to 50 °F (10 °C), aerate the wort if using liquid yeast, pitch the yeast, and ferment until complete. Rack to secondary, then continue to lager for 6–8 weeks at or near 32 °F (0 °C).

Rack the beer, prime and bottle condition, or keg and force carbonate.

German Pilsner

(5 gallons/19 L, extract only)
OG = 1.046 FG = 1.008
IBU = 29 SRM = 3.5 ABV = 5%

INGREDIENTS

6.3 lbs. (2.9 kg) Pilsner liquid malt extract
7 AAU Magnum hops (60 min.)
  (0.5 oz./14 g at 14% alpha acids)
2 AAU Hallertauer hops (15 min.)
  (0.5 oz./14 g at 4% alpha acids)
0.5 oz. (14 g) Hallertauer hops (0 min.)
Wyeast 2124 (Bohemian Lager), White Labs WLP830
  (German Lager), or SafLager W-34/70 yeast
⅞ cup corn sugar (if priming)

STEP BY STEP

Use 6.5 gallons (24.5 L) of water in the brew kettle; heat to 158 °F (70 °C). Turn off the heat. Add the malt extract and stir thoroughly to dissolve completely. Turn the heat back on and bring to a boil.

Boil the wort for 60 minutes, adding hops at the times indicated. Chill the wort to 50 °F (10 °C), aerate the wort if using liquid yeast, pitch the yeast, and ferment until complete. Rack to secondary, then continue to lager for 6–8 weeks at or near 32 °F (0 °C).

Rack the beer, prime and bottle condition, or keg and force carbonate.

Pre-Prohibition Lager

(5 gallons/19 L, all-grain)
OG = 1.053 FG = 1.012
IBU = 32 SRM = 3 ABV = 5.4%

INGREDIENTS

7.75 lbs. (3.5 kg) Pilsner malt
8 oz. (227 g) Munich malt
2.5 lbs. (1.1 kg) flaked maize
2 AAU Hallertauer (first wort hop)
  (0.5 oz./14 g at 4% alpha acids)
6.5 AAU Magnum (60 min.)
  (0.5 oz./14 g at 13% alpha acids)
2 AAU Hallertauer (10 min.)
  (0.5 oz./14 g at 4% alpha acids)
1 oz. (28 g) Hallertauer hops (2 min.)
Wyeast 2035 (American Lager), White Labs WLP833
  (German Bock), or SafLager W-34/70 yeast
¾ cup corn sugar (if priming)

STEP BY STEP

This recipe uses reverse osmosis (RO) water. Adjust all brewing water to a pH of 5.5 using phosphoric acid. Add 1 tsp. of calcium chloride ($CaCl_2$) to the mash.

This recipe uses a step mash. Use enough water to have a moderately thick mash (1.5 qts./lb. or 3.1 L/kg). Mash in the malts and maize at 131 °F (55 °C) and hold for 15 minutes. Raise the temperature to 145 °F (63 °C) and hold for 45 minutes. Raise the temperature to 158 °F (70 °C) and hold for 15 minutes. Begin recirculating, raise the mash temperature to 169 °F (76 °C), and recirculate for 15 minutes.

Put the first wort hops in the boil kettle, then sparge slowly and collect 6.5 gallons (24.5 L) of wort.

Boil the wort for 90 minutes, adding hops at the times indicated in the recipe.

Chill the wort to 54 °F (12 °C), aerate if using a liquid yeast, pitch the yeast, and ferment until complete. Rack to secondary and lager for two months at or near 32 °F (0 °C).

Rack the beer, prime and bottle condition, or keg and force carbonate.

Pre-Prohibition Lager

(5 gallons/19 L, extract only)
OG = 1.053 FG = 1.012
IBU = 32 SRM = 3 ABV = 5.4%

INGREDIENTS

5 lbs. (2.3 kg) extra light or Pilsner liquid malt extract
0.33 lb. (150 g) Munich liquid malt extract
1.6 lbs. (726 g) rice syrup
2 AAU Hallertauer (first wort hop)
(0.5 oz./14 g at 4% alpha acids)
6.5 AAU Magnum (60 min.)
(0.5 oz./14 g at 13% alpha acids)
2 AAU Hallertauer (10 min.)
(0.5 oz./14 g at 4% alpha acids)
1 oz. (28 g) Hallertauer hops (2 min.)
Wyeast 2035 (American Lager), White Labs WLP833
(German Bock), or SafLager W-34/70 yeast
¾ cup corn sugar (if priming)

STEP BY STEP

For the extract version of this recipe we will use rice syrup instead of corn. Use 6.5 gallons (24.5 L) of water in the brew kettle; heat to 158 °F (70 °C).

Turn off the heat. Add the malt extracts and rice syrup and stir thoroughly to dissolve completely. Add the first wort hops to the kettle. Turn the heat back on and bring to a boil.

Boil the wort for 60 minutes, adding hops at the times indicated in the recipe.

Chill the wort to 54 °F (12 °C), aerate if using a liquid yeast, pitch the yeast, and ferment until complete. Rack to secondary and lager for two months at or near 32 °F (0 °C).

Rack the beer, prime and bottle condition, or keg and force carbonate.

New Zealand Pilsner

(5 gallons/19 L, all-grain)
OG = 1.050 FG = 1.012
IBU = 38 SRM = 3 ABV = 5%

INGREDIENTS

5 lbs. (2.3 kg) North American 2-row malt
5 lbs. (2.3 kg) German Pilsner malt
5 oz. (142 g) German wheat malt
5.3 AAU Motueka™ hops (first wort hop)
(0.7 oz./20 g at 7.5% alpha acids)
6 AAU Nelson Sauvin™ hops (10 min.)
(0.5 oz./14 g at 12.1% alpha acids)
1 oz (28 g) Riwaka™ hops (5 min.)
SafLager W-34/70, White Labs WLP830 (German Lager),
or Imperial Yeast L13 (Global) yeast
¾ cup corn sugar (if priming)

STEP BY STEP

This recipe uses reverse osmosis (RO) water. Adjust all brewing water to a pH of 5.5 using phosphoric acid. Add 1 tsp. calcium chloride ($CaCl_2$) to the mash.

This recipe uses a single infusion mash with a mashout. Use enough water to have a moderately thick mash (1.5 qts./lb. or 3.1 L/kg). Mash in all the grains at 149 °F (65 °C) and hold this temperature for 60 minutes. Raise the temperature by infusion or direct heating to 168 °F (76 °C) to mashout. Recirculate for 15 minutes. Sparge slowly with 168 °F (76 °C) water until 6.5 gallons (25 L) of wort is collected.

Boil the wort for 75 minutes, adding the hops at times indicated in the recipe. The first wort hops are added to the kettle just before lautering begins. Chill to 48 °F (9 °C) and rack to the fermenter.

Oxygenate if using a liquid yeast and then pitch yeast. Start fermentation at 48 °F (9 °C), allowing temperature to rise naturally to 50 °F (10 °C) as fermentation progresses. After fermentation is complete, rack the beer to secondary and lager for 12 weeks at or near 0 °F (32 °C). Fine the beer with gelatin if needed.

Rack the beer, prime and bottle condition, or keg and force carbonate.

New Zealand Pilsner

(5 gallons/19 L, extract only)
OG = 1.050 FG = 1.012
IBU = 38 SRM = 3 ABV = 5%

INGREDIENTS

6.8 lbs. (3.1 kg) Pilsner liquid malt extract
5.3 AAU Motueka™ hops (first wort hop)
(0.7 oz./20 g at 7.5% alpha acids)
6 AAU Nelson Sauvin™ hops (10 min.)
(0.5 oz./14 g at 12.1% alpha acids)
1 oz (28 g) Riwaka™ hops (5 min.)
SafLager W-34/70, White Labs WLP830 (German Lager),
or Imperial Yeast L13 (Global) yeast
¾ cup corn sugar (if priming)

STEP BY STEP

Use 6 gallons (23 L) of water in the brew kettle; heat to 158 °F (70 °C).

Add the malt extract and stir thoroughly to dissolve the extract completely. You do not want to feel liquid extract at the bottom of the kettle when stirring with your spoon. Turn the heat back on and bring to a boil.

Boil the wort for 60 minutes, adding the hops at times indicated in the recipe. The first wort hops are added to the kettle just after the malt extract is dissolved but before bringing to a boil.

Chill to 48 °F (9 °C) and rack to the fermenter.

Oxygenate if using a liquid yeast and then pitch yeast. Start fermentation at 48 °F (9 °C), allowing temperature to rise naturally to 50 °F (10 °C) as fermentation progresses. After fermentation is complete, rack the beer to secondary and lager for 12 weeks at or near 0 °F (32 °C). Fine the beer with gelatin if needed.

Rack the beer, prime and bottle condition, or keg and force carbonate. BYO

Photo courtesy of MoreBeer!

FERMENTING UNDER PRESSURE

Can lagers be made in two weeks?

by John Blichmann

Pressure fermentation has taken off among homebrewers the past few years, but the effect of pressure suppressing ester formation during fermentation has been known for many years. I first came across a white paper article about ester suppression under pressure in the early 2000s. And it was an old paper at that time! I wish I had saved a copy, but at the time I just found it an interesting tidbit of information. As most brewers know, lager yeasts and cold fermentation temperatures greatly suppresses the formation of the fruity esters that we know and love in ales. Those same flavors can be inappropriate in clean lagers where malt and hops take the front seat in flavor profile.

Esters are made by yeast as they metabolize wort fermentables, amino acids, and lipids during fermentation. As yeast metabolism increases, ester production increases. Lagers have traditionally been fermented at 50–55 °F (10–13 °C). Lager yeast are very unique genetically that they can grow (producing ethanol) at this temperature range. Properly oxygenating wort to 10–15 ppm of dissolved oxygen when using liquid yeast also helps to reduce ester formation (though this oxygenation step is not required if using dry yeast). The result: A clean tasting beer. However, brewers would love to ferment warmer because the fermentation proceeds faster. By applying pressure to the fermentation, yeast metabolism is changed, thereby decreasing ester formation. Now the fermentation temperature can be increased, resulting in a faster fermentation.

In addition to suppressing ester formation, fermenting at room temperature also greatly reduces diacetyl, the butterscotch flavor in some beers. Diacetyl is usually considered a flaw in lagers in detectable concentrations, though in low levels it can add a fullness to the body. Fermenting under pressure, and at room temperature, allows homebrewers to make a clean lager-style beer if temperature control is not available. Since fermenting at room temperature does ferment much faster, and doesn't create much diacetyl, there is no need to age (lager) the beer to let the yeast clean up those compounds, nor is there a need for a diacetyl rest. Ales, on the other hand, derive their unique flavor profiles from the esters formed during fermentation, so pressure fermentation would be counterproductive to most ale styles.

While fermentation temperature control is known to be vital to producing quality beers, particularly lagers, glycol chillers and temperature-controlled freezers were not common for homebrewers when the paper I referenced earlier was written more than a quarter-century ago, and out of financial reach for most.

Fast forward many years from when I first read about pressure fermentations, as we (Blichmann Engineering) got more and more feedback from homebrewers asking about temperature control products so they could brew lagers, I recalled that white paper and thought perhaps that would be a great solution for brewing lagers at home.

In 2012, Blichmann Engineering had just developed the Cornical conical keg and fermenter product that also allows fermentation pressures up to 30 PSI. While it was originally developed as a convenient way to ferment and dispense out of the same vessel, I also had pressure fermentation in the back of my mind for this product. But we didn't have hard data on the effects of pressure fermentation and the suppression of esters to make knowledgeable recommendation to homebrewers. So, I reached out to my good friend Chris White of White Labs, who kindly offered to assist in my experimentation as he, too, had an interest in this phenomenon. He sent yeast, helped develop the experiment, and analyzed the beer samples in their lab and using their tasting panel.

The results were quite interesting, to say the least. The added benefits, in addition to ester suppression, is the ability to ferment at room temperature and forego elaborate temperature control, the ability to naturally carbonate the beer during fermentation, utilization of CO_2 to pressure transfer to kegs, and the ability to make warm-fermented yet clean lagers in a fraction of the usual time. Of course, today pressure fermentation is a more common technique, with most equipment manufacturers offering pressure-capable fermenters made from stainless steel and/or PET plastic and sized for homebrewers.

Before we get into the details of the experiment, let's discuss the equipment needed and how to safely operate it. The first thing to discuss is pressure. While 15 PSI (pounds per square inch) may not sound like a lot, the big factor is the surface area on which it is pushing and how much force that generates. My intent isn't

Photo courtesy of MoreBeer!

One benefit of pressure fermentation is the ability to do pressure transfers from fermenter to keg.

to scare the heck out of you, but it is my intent to help you understand why it is so very important to follow safe practices. Force = Pressure x Area. So, over a 1-inch (2.5-cm) square, 15 PSI will push with 15 lbs. (6.8 kg) of force, a 4-inch (10-cm) diameter lid at 15 psi equates to 189 lbs. (86 kg) of force, and a 16-inch (41-cm) diameter conical lid equates to 3,000 lbs. (1,360 kg) of force! The key to safely fermenting under pressure is to purchase equipment that is designed and rated for pressure and equipped with a safety relief valve.

SAFETY RULES

Let's start here. READ and UNDERSTAND the manufacturer's manual.

NEVER operate a pressure vessel of ANY kind that does not have a separate dedicated over-pressure relief valve (PRV), and a device to release all internal pressure safely such as a pull ring or vent valve so that all pressure can be reduced to zero. A spunding valve (discussed later) is NOT a pressure safety device. In addition to a spunding valve, you will need a separate pressure relief valve. If you try venting during fermentation through a PRV there is a good chance that it may plug with hops or yeast and no longer be able to relieve an overpressure at the design pressure.

ALWAYS be 100% sure before removing any lid or accessory that the pressure in the vessel is fully released and the pressure inside the vessel is zero. Then carefully loosen any clamps keeping your body clear of the path of the lid or device should it be inadvertently under some pressure. The vent should remain open the entire time the tank is being disassembled. In many designs, much like a Corny keg, the pressure relief valve can be unscrewed and removed to ensure the vessel is fully vented.

NEVER exceed the manufacturer's rated pressure, or tamper with any pressure relief device.

For the fermenter itself: PET fermenters are an economical choice, as are Sankey and Corny kegs. But make sure you use a separate PRV and spunding valve!

The device used to effectively control pressure during fermentation is a spunding valve. These are devices used to vent fermentation gas created during fermentation while maintaining a desired pressure in the vessel. The word "spunding" stems from the German word *spund*, which means "bung." Basically, a valve to seal off a barrel or vessel. Most spunding valves will include a pressure gauge or pressure indication so that the desired pressure can be dialed in. Once set at the desired pressure, any pressure exceeding the set pressure will be released through the spunding valve. Some spunding valves have a small bowl containing water to give a visual indication of fermentation activity (as shown in the photo on page 36). Others have a means to affix a hose to vent into a bucket of water (as shown in the example on page 40), and

A spunding valve is required to set the pressure you want inside of your fermenter. The valve releases pressure if it builds up over this set amount.

others simply vent the gas directly to atmosphere.

Spunding valves are adjustable pressure relief valves that allow you to vary the set pressure as desired. Safety valves and spunding valves both utilize a spring pushing a seal into a seat; however, the spunding valve has a means to adjust the pressure to the desired level, commonly a threaded rod to compress the spring more or less, which changes the applied force into the seat. Recall the pressure and force equation discussed earlier. Same physics here. The easiest way to set the spunding valve is to use a CO_2 tank and set the regulator at your desired pressure. Connect the tank to the vessel and slowly pressurize. As you hear gas venting or bubbles in the spunding valve, slowly turn the pressure adjustment on the spunding valve until you no longer see or hear venting gas. Check that the gauge on the regulator, or the gauge on the spunding valve if equipped, is at your desired pressure. Disconnect the CO_2 supply and you are set. Until fermentation commences, you will likely see the pressure drop as CO_2 dissolves into the wort. But as fermentation picks up you will quickly see the pressure rise and stabilize at your set pressure.

WHAT WE LEARNED IN OUR EXPERIMENT

The purpose of the test was to quantitively and qualitatively measure the effects of pressure on ester suppression, hop expression, and overall flavor and body. A Munich helles was selected as the test beer so that these characteristics would be easy to detect. One 20-gallon (76-L) batch was split into four identical conical fermenters (the Blichmann Cornical, to be exact). An identical amount of White Labs WLP833 (German Bock Lager) yeast was pitched to 15 million cells/mL, and the wort was oxygenated to a measured 10 ppm dissolved oxygen using pure oxygen and an oxygenation wand.

The control fermenter followed a traditional cold lager fermentation with a diacetyl rest. The other three were fermented at room temperature (68 °F/20 °C) in a temperature-controlled upright freezer. One fermenter was set at 0 PSI (atm pressure), one at 15 PSI (1 BAR), and one at 30 PSI (2 BAR).

The control lager batch finished fermenting in under two weeks and was then put through a diacetyl rest and lagered. The total process took eight weeks. The room temperature-fermented batches were complete within two weeks. After fermentation, several bottles of each beer were shipped to Chris for his lab to analyze with their gas chromatograph and for the White Labs tasting panel to do their qualitative testing. The highlights of these tests are listed in Table 1 and illustrated in the graphs below it on page 41.

Conveniently, the Indiana State Fair beer competition was the following weekend, so I brought bottles for four Beer Judge Certification Program (BJCP) national rank and above judges, including Gordon Strong. They were told that all four beers were from the same wort, but that different fermentation techniques were done on each of the four samples. The bullets below summarize the results of the White Labs and Indiana State Fair judging panels, and as you'll see they align with the qualitative data:

- **Traditional Lager:** Low ester levels, low to moderate diacetyl, malty, balanced hop character.
- **0 PSI:** High esters for style, very low diacetyl, noticeable fruity esters, mild bitterness.
- **15 PSI:** Lower esters than traditional lager, very low diacetyl. Malt-forward with balanced hop character. Slightly less malty than traditional lager profile.
- **30 PSI:** Very low esters and diacetyl. Muted maltiness, with a somewhat harsh hop bitterness.

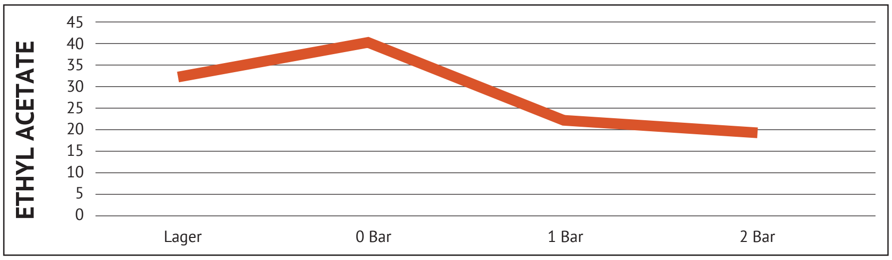
Based on the results, the beer that was the maltiest and had the best hop balance true to style was still the traditional lager method, most likely due to the carbohydrate metabolism at that temperature. Sulfur notes were also most appropriate with the traditional lager method. A close second was the 1 BAR (15 PSI) room temperature brew. Above this pressure, maltiness and body are noticeably reduced, and hop expression is notably harsher. Esters were lower in those fermented at both 1 and 2 BAR compared to the traditional lager fermentation. They also fermented a little drier, due to the higher temperature.

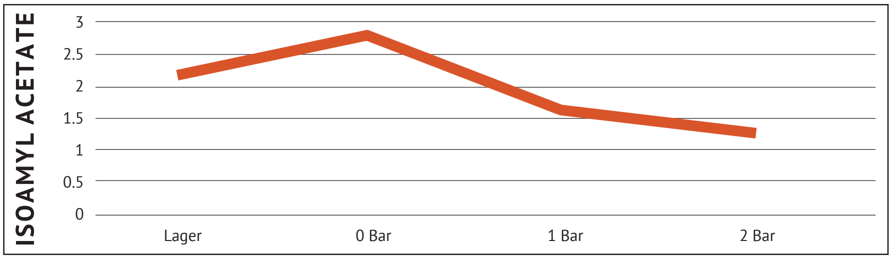
So, can you make a true lager substitute using pressure fermentation at warmer temperatures in a fraction of the time? I don't think so . . . but you can come pretty darn close. The differences were detectable when tasting the traditional lager and lager fermented at 1 PSI side-by-side, though they were quite subtle. I'd venture a guess that tasting one today and the other tomorrow would leave most without serious beer flavor training hard pressed to tell the difference.

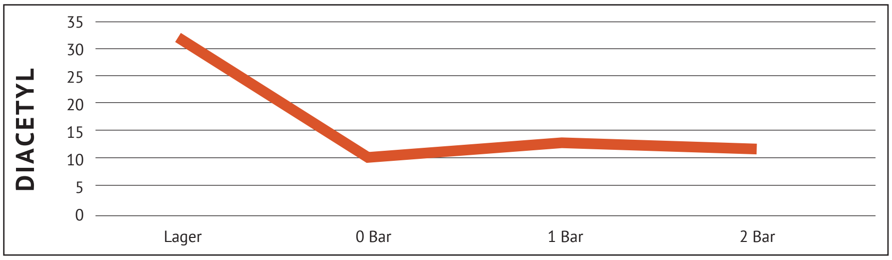
Wrapping it all up, pressure fermentation is a simple way to make great tasting lager-style beers without all the cooling equipment and controls normally needed for lagers, or the long lagering time. But keep the pressure to that 10–15 PSI range for the best results. I also recommend running your own side-by-side experiment to see the difference for yourself!

Table 1: Pressure Fermentation Quantitative Analysis

	UNITS	CONTROL	0 BAR	1 BAR	2 BAR
ABV	%	5.06	5.09	5.11	5.12
ABW	%	3.97	3.99	4.01	4.01
Apparent Attenuation	%	80.14	81.02	80.93	80.66
Apparent Extract	Plato	2.36	2.25	2.27	2.31
Calories	(12 oz.)	156.58	155.75	156.47	157.18
Color	SRM	5.52	5	5.58	5.8
Original Extract	Plato	11.89	11.84	11.89	11.94
pH		4.46	4.35	4.34	4.55
Real Deg. Attenuation	%	66.14	66.84	66.77	66.57
Real Extract	Plato	4.2	4.09	4.12	4.16
Specific Gravity	20C	1.009	1.009	1.009	1.009
Diacetyl	ppb	32.07	<10	12.61	12.2
IBU	BU	22.5	16.5	20	21
1-Propanol	ppm	15.79	20.96	18.19	17.57
Acetaldehyde	ppm	10.77	5.08	4.26	6.91
Acetone	ppm	none	none	none	none
Amyl Alcohol	ppm	52.03	63.23	56.79	52.75
Ethyl Acetate	ppm	33.01	40.5	23.52	19.7
Ethyl Butryate	ppm	none	none	none	none
Isoamyl Acetate	ppm	2.18	2.78	1.66	1.26
Isobutanol	ppm	10.17	16.23	15.79	11.97
Isobutyl Acetate	ppm	none	none	none	none
Methanol	ppm	none	none	none	none







UNDERSTANDING MASH Chemistry

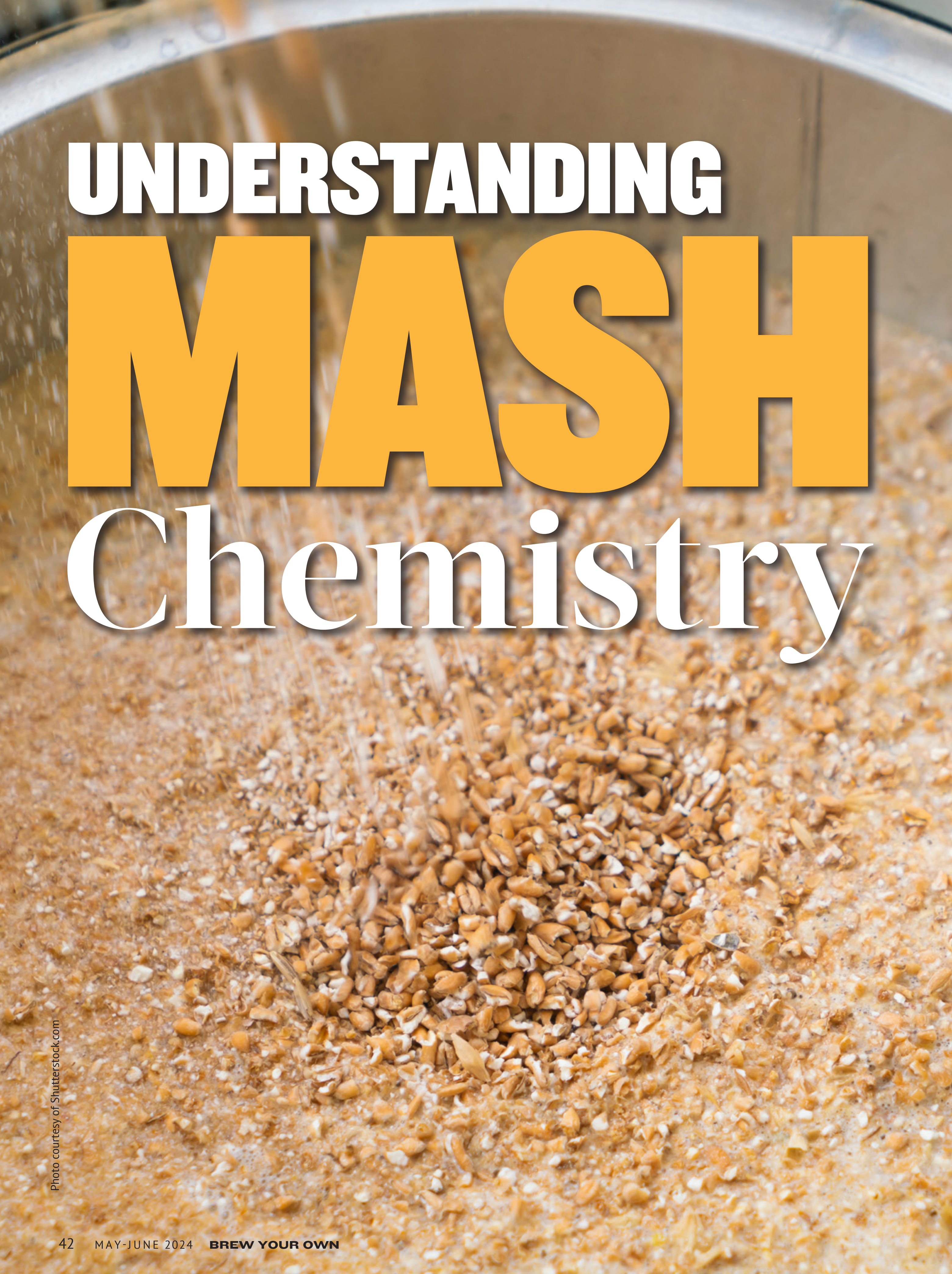


Photo courtesy of Shutterstock.com

Are water adjustments the missing piece in your homebrew?

by Keith T. Yager

Mash chemistry is one of those final pieces of the brewing puzzle that many homebrewers, and even some pros, choose to ignore. Perhaps they think it is too complicated. Or maybe they are just lazy. Either way, it's a shame because all-grain brewers brew their best beer with at least a basic understanding of how grains, minerals, and acids affect mash pH. It's also fairly simple once the basics are understood — no chemistry degree required! Though, of course, it certainly wouldn't hurt.

You might recall from high school chemistry that pH is a logarithmic scale that expresses the alkalinity or acidity of a substance. pH is considered neutral at 7. A solution under pH 7 is considered acidic, while over pH 7 is considered alkaline.

Distilled water clocks in at pH 7 right out of the distillation process, but as it picks up CO_2 from the atmosphere, its pH will drop to around 6.5 because CO_2 is acidic. Dissolved minerals can likewise lower or raise the pH of water. Dissolved minerals are the primary driver of water's pH. The pH of most municipal water will hover between 6.5 and 8.5, determined mainly by dissolved minerals.

However, the pH of water is of minor importance to brewing. What's important is the mash pH, which can change drastically depending on the grist bill.

When we add pale malt to our brewing water, it will lower the pH because pale malt is mildly acidic. Mashing pale malt with almost any potable water source will lower the mash into the pH 5–6 range. Most likely, it will drop the range between 5.4–5.8. And that's great! Because this is within the enzymatic conversion range. Practically, that's all you have to do: Mix your grain with hot water, and mashing will take care of itself. *Voila!*

But, if we want to make the best beer possible, the range of pH we are looking for is a bit narrower — for most light beer, we are looking for a pH range of about 5.2–5.4, and for most dark beer, we are looking for a range between 5.4–5.6.

As mentioned, pale malt is mildly acidic, so when mixed with water it lowers the pH. Darker malt, especially roasted malt, is even more acidic. Combining a 100% Pilsner malt grist with distilled water will give us a pH of about 5.75. If we mix a stout grist with lots of roasted malts in distilled water, our pH may drop below 5 because of the acidity of dark malts.

Sticking with these two examples, if we add a weak acid such as lactic acid to the Pilsner mash, we can lower the pH of that solution closer to 5.2–5.4. Likewise, if we add a weak base, such as sodium bicarbonate, to our stout mash, we can raise the pH to 5.4–5.6. How much acid or base we need to affect the pH depends on the makeup of the grist since malt will act as a buffer and resist the change. If the water is high in dissolved minerals, especially carbonate and bicarbonate, these will also serve as a buffer.

BUFFERS IN THE WATER AND MASH

Back to our foggy high school chemistry class, recall that buffers in a solution act to resist pH change. When adding an acid or a base to the mash, the pH first appears not to change. Envision the mash represented as an empty glass, and the water added to it represents the pH. The glass can only hold so much water. Drop by drop, you add water until it reaches a point where it overflows. You can think of the mash working the same way: You add acid or base milligram by milligram, and very little change happens until suddenly the buffers in the mash can't resist anymore, and the pH changes drastically.

In the example of the stout or Pilsner grist, we used distilled water as a theoretical example. Real-world mashes use water with at least trace minerals since they improve enzymatic action and yeast health.

Distilled water has almost no buffering capacity, but dissolved solids in our water can act as buffers, specifically carbonate and bicarbonate. This means that when we add our Pilsner malt or our stout grist to our tap water, the pH will be affected by the buffering capacity of these dissolved solids, which will resist the pH change.

Consider the water that flows from your faucet: Tap water that has low mineral content has minimal buffering capacity, similar to, but not quite as extreme as, distilled water. In contrast, water high in minerals — especially carbonate and bicarbonates — will have more buffering capacity. Carbonate and bicarbonate are the big playmakers here and are the dissolved solids that mainly affect the water's alkalinity. The alkalinity is responsible for most of the buffering capacity in our water, which directly affects the pH of the mash. Therefore, highly alkaline water has a very high buffering capacity and resists pH change.

In contrast, low alkalinity water has much less buffering capacity, and the pH can be easily changed. What makes things interesting is that the alkalinity of your water will determine what color beer it is best suited to brew, meaning where the pH will fall into range without (or with minimal) mineral or acid additions. This information can be found in your water report.

WATER REPORT AND ALKALINITY

There's lots of information to unpack in a typical water report, but only a few items are helpful for brewing. The information also isn't necessarily standardized in the way it is presented and might read differently depending on your municipality. But every report should list an approximation of the following:

- Calcium (Ca^{2+})
- Magnesium (Mg^{2+})
- Sulfate (SO_4^{2-})
- Sodium (Na^{+})
- Chloride (Cl^{-})
- Bicarbonate (HCO^{3-})
- Alkalinity, or Alkalinity as HCO^{3-}
- Hardness, or Hardness as HCO^{3-}

Calcium, magnesium, sulfate, sodium, and chloride all have some effect on the final beer's flavor and, to a lesser degree, the mash pH (we will get to these in a moment). But it's the bicarbonate (HCO^{3-}) that has the most impact on the mash alkalinity and, therefore, the mash's buffering power. So much so that if your water report doesn't have a value for "bicarbonate/HCO^{3-}," you can substitute the value given as "alkalinity" or "alkalinity as $CaCO_3$" since the majority of alkalinity will usually be bicarbonate.

The alkalinity of your water will determine what color of beer your water is best suited to brew. Water between 0–50 ppm (mg/L) levels is ideal for extremely pale beer. For pale to amber beers, 50–150 ppm (mg/L), and for dark beers, 150–300 ppm (mg/L). Higher alkalinity will help to neutralize darker and more acidic malts and target the mash into the proper enzymatic pH range.

"Hardness" or "hardness as HCO^{3-}" refers to water's calcium and magnesium concentration. While "alkalinity as HCO^{3-}" and "hardness as HCO^{3-}" are not the same, they are somewhat linked. For example, boiling water high in "hardness" can cause some of the bicarbonate and/or carbonate to bind with the calcium and/or magnesium, precipitating some of it out as calcium carbonate and lowering the water's hardness and alkalinity. This is known as *temporary hardness.* It was once a standard method to soften brewing water while reducing its alkalinity (the layer of calcium carbonate will be seen on the bottom of the kettle after the boil and time to settle). However, homebrewers will probably find it easier and less energy-intensive to dilute their water with distilled or reverse osmosis (RO) water instead of boiling to reduce hardness and alkalinity. It's also more accurate.

For instance, if the alkalinity of your water is 100 and you split it 50/50 with distilled water, the alkalinity will be at 50 ppm — within the range of pale beer so that only a tiny amount of acid will be needed (if any) to hit your pH. You can use whatever ratio of distilled or RO water you like to get your alkalinity to your desired ppm, but remember, if you use all or close to all distilled or RO water, you need to add some minerals back in — most likely calcium, at the very least, for yeast health.

CHECKING THE MASH pH

As stated, as long as it is between the "normal range" of about 6.5–8.5 pH, the pH of your water is of little concern. What matters is the pH of the mash.

The best way to check the pH of the mash is with a pH meter that has been properly calibrated between 4.01 pH and 7.01 pH using calibration solutions. Every pH meter brand is different, and the calibration and usage instructions must be followed. The pH meter should be calibrated before every brewing session.

When checking the mash or wort pH, it's best to cool the sample to room temperature for an accurate reading. A correction must be made if the sample is too hot or too cold. A pH reading at mash temperature will be off by about +0.2 points. A sample at refrigeration temperature will be off by about -0.01.

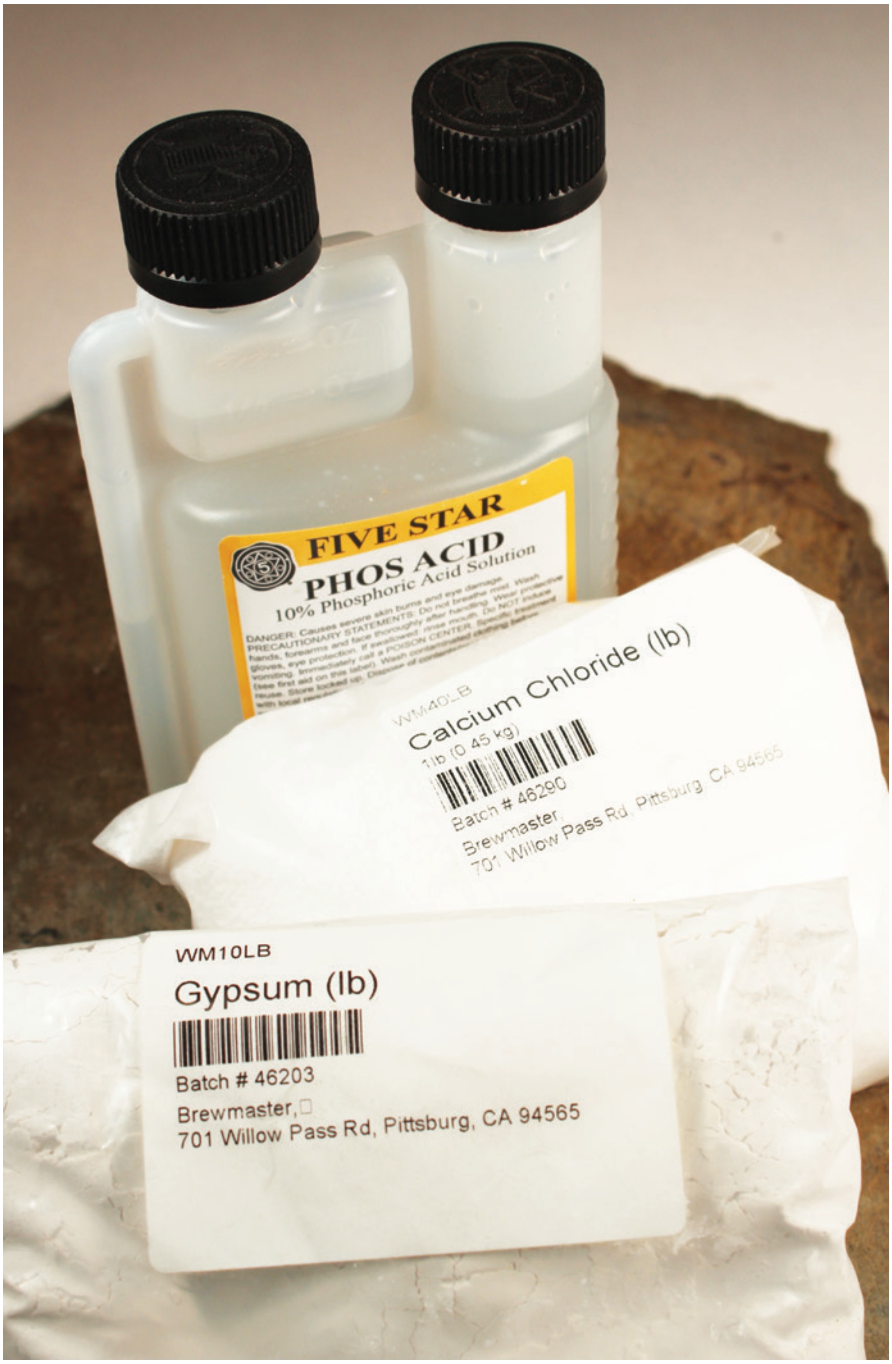
Disposable pH strips are better than nothing, but their accuracy may be suspect, and the reading challenging to determine. Be sure to use pH papers within the 4.01 pH and 7.01 pH range.

LOWERING THE pH IN THE MASH

Remember: The alkalinity of the water acts as a buffer to the mash, and the mash acts as a buffer to anything we add to adjust its pH. Also, recall that for a pale beer, the ideal alkalinity of our water is under 50 ppm.

Water alkalinity under 50 ppm doesn't mean that adjustments won't be needed on pale beers to bring the pH between 5.2–5.4. It just means that smaller adjustments will be required. Likewise, just because the alkalinity of water is over 50 ppm doesn't mean you can't brew pale beers. While dilution with distilled or RO is preferred, it isn't always possible. Many brewers with high alkalinity use acids, acidulated malts, etc., to lower the pH of their mash to the desired range. The higher the alkalinity of the water, the more acid or acidulated malt, etc., will be needed. The problem is that the more acid added, the more potential it has to change the beer's flavor.

Because each mash and water source is different, it is difficult to calculate how much acid will be needed for any given mash to make adjustments. Based on input, the brewing water software can estimate



Phosphoric acid, calcium chloride, and calcium sulfate (gypsum) are three options brewers have to lower mash pH, however there are other ways as well, including lactic acid, acidulated malt, or soured wort.

how much acid is required to adjust the mash to your desired pH. If you don't have access to software, then the best way to adjust the pH in your mash is to add the acid a drop or two at a time, stir well, and check to see if it has made a difference. Obviously, the smaller the mash, the smaller the amount added. Likewise, the higher the alkalinity of the water, the more acid is required. Once the capacity of the buffering power is reached, pH change happens rapidly.

Lactic acid: Is a common food-grade acid used to adjust the pH in the mash since the flavors it provides are pleasant when under a certain threshold. But, if too much is used, it can create a sour "twang" that can detract from the beer.

Phosphoric acid: Is another common food-grade acid used to adjust the mash pH. In beer, it is almost flavorless. Malt naturally releases phosphates during the mash, which resembles phosphoric acid's flavor.

Acidulated (or acid) malt: The Reinheitsgebot (German Law of Beer Purity) doesn't allow any acid additions to be introduced when brewing, so the Germans found a clever way around this: Acidify the malt with a mild lactic acid fermentation.

Every 1% acidulated malt (by weight) of the total grain bill reduces the mash pH by 0.1 points. If your water is high in alkalinity, you can use up to 10% acid malt in the total grain bill without off-flavors.

Sauergut: German brewers have also skirted the Reinheitsgebot by souring a small portion of wort, called *sauergut,* and adding it to the mash to lower the pH. Sauergut can be made by adding a pure pitch of *Lactobacillus* or a small amount of barley malt (already naturally crawling with *Lactobacillus*) to the sample portion. The wort will then acidify and sour, as quick as in just few hours when kept about 108–112 °F (42–44 °C). A common practice is making the sauergut 12–24 hours before brewing, letting the sauergut sour to around pH 3.5 or under, and then portioning it off into the main mash to adjust the pH as necessary. Many brewers find adding sauergut to their mash is an easy way to adjust the pH and put a unique flavor print on their beer.

Minerals to lower pH: Calcium chloride ($CaCl_2$) and Calcium sulfate, aka gypsum ($CaSO_4$), can also lower the mash pH, but since they are flavoring salts, their flavor needs to be taken into consideration first. The amount of $CaCl_2$ or $CaSO_4$ needed to make pH changes may put them out of the acceptable flavor range unless using water with extremely low alkalinity. Their usage will be discussed later.

RAISING THE pH IN THE MASH

The pH of the mash should only need to be raised when brewing amber or dark beers. For stouts or porters, high alkalinity is necessary to land in the 5.4-5.6 zone. If the water source is already high in alkalinity, only minor adjustments will be needed (if any). Sodium bicarbonate ($NaHCO_3$) and calcium carbonate ($CaCO_3$) are the most common minerals to raise the alkalinity.

Calcium carbonate ($CaCO_3$) is largely flavorless and does a great job raising alkalinity in nature due to time and dissolved CO_2 from the atmosphere. In the brewery, calcium carbonate will not dissolve well in tap water. More of it will dissolve in the mash due to the lower pH, but much of it will precipitate out. It will raise your calcium and may increase your alkalinity, but it is difficult to say how much. Because it is unpredictable, it's not the best method of raising alkalinity. Since calcium is soluble, 1 gram of calcium carbonate per gallon (4 L) should raise calcium by about 50–55 ppm (mg/L). Since the carbonate is less soluble, 1 gram per gallon (4 L) may increase your $CaCO_3$ by as much as 160 ppm (mg/L), or it could be much less, depending on how much gets dissolved.

Sodium bicarbonate ($NaHCO_3$), or baking soda, will dissolve well in both brewing water and the mash and does a consistent job of raising the alkalinity and the pH of the mash. The problem is that it must be added judiciously since it will increase the sodium and affect the beer's overall flavor. The flavor threshold of sodium varies from person to person, but a good rule is to keep the sodium (Na^+) under 100 ppm (mg/L) lest the beer taste "salty." One gram per gallon (4 L) of sodium bicarbonate in distilled water will raise the carbonate to about 190 ppm (mg/L) and the sodium to about 75 ppm (mg/L). For dosage, a good rule is not to go over 1.25 grams per gallon (4 L) to avoid issues with excessive sodium. If more alkalinity is desired, but the sodium is hitting the threshold, the brewer should try blending in some calcium carbonate.

MINERALS FOR BEER FLAVOR

The other minerals on the water report don't do as much to affect the mash pH, but they do play a nuanced, though vital, role in beer flavor. As an analogy, let's use table salt: When cooking, the right amount of salt makes the dish "pop." Not enough, and the flavor is bland and boring. Too much, and the meal is inedible. Using minerals in brewing can have similar consequences.

Calcium sulfate (gypsum): Gypsum profoundly affects beer's "dryness" and can accentuate hop bitterness and, to some extent, hop aroma. It is historically the most popular flavoring salt used in brewing.

One gram of gypsum per gallon (4 L) of water will add about 60–62 ppm (mg/L) of calcium and 145–147 ppm (mg/L) of sulfate. It's best to stay below 350 ppm (mg/L) of sulfate. While many brewers add gypsum indiscriminately to their mash (and even wort), remember that it is not a magical flavoring salt and can be overdone, creating harsh and unpleasant flavors.

Calcium chloride ($CaCI_2$): Calcium chloride emphasizes malt character while softening hop flavor or bitterness. It is nearly flavorless but will "sweeten" and "round" malt flavors when used at low levels. Calcium chloride is a valuable tool to raise water's calcium to acceptable levels without raising sulfate.

One gram of calcium chloride per gallon (4 L) of water will raise the calcium to about 70–72 ppm (mg/L), while raising the chloride level to about 125–127 ppm (mg/L). It is best to keep the chloride level under 250 ppm (mgLl) for most beers, as too much chloride can make a beer taste salty or chemically.

Epsom salt ($MgSO_4$): Epsom salt is used to raise magnesium (Mg) or to raise sulfate (SO_4) without raising calcium. It is commonly employed to recreate the classic Burton-on-Trent water profile for British-style ales (along with gypsum). However, Epsom salt must be used sparingly because magnesium can have a laxative effect — which could create quite a surprise at an inopportune time for the unsuspecting drinker.

One gram of Epsom salt per gallon (4 L) of water will raise the sulfate to about 101–103 ppm (mg/L) and the magnesium to about 24–26 ppm (mg/L). It's best to keep the magnesium under about 35 ppm (mg/L).

Salt (sodium chloride, NaCl): Non-iodized table salt affects flavor and can make the beer taste more "full" and "round." If your beer tastes "thin," adding a little salt may fill out the flavors and make for a more tasty beer. Be sure to use only non-iodized salt since iodine can affect yeast health.

Salt will raise the sodium levels as well as the chloride levels in brewing. One gram of salt per gallon (4 L) of water will increase the sodium (Na^+) by about 102-104 ppm (mg/L) and the chloride (Cl) by about 158–160 ppm (mg/L). While people's flavor threshold to salt will vary, keeping sodium under 100 ppm (mg/L) is best. Avoid salt when using sodium bicarbonate since it can quickly raise sodium to unacceptable levels.

Sodium bicarbonate and calcium bicarbonate: Neither of these salts should be used as flavoring salts. However, they can affect flavor when combined with other salts: Calcium bicarbonate raises sodium, and both salts raise calcium. Watch your sodium and calcium levels when using these salts in conjunction with others.

Sulfate-to-chloride ratio: The sulfate-to-chloride ratio should be considered for any beer style, especially hop-forward beers. For example, hazy pale ales typically use a 1:2 sulfate-to-chloride ratio to emphasize the "softness" of these beers. On the other hand, a West Coast IPA may use a 2:1 sulfate-to-chloride ratio to accentuate dryness and hop bitterness.

You can use whatever sulfate-to-chloride ratio you like (1:3, 1:1, 4:1, 0:1, 1:0, etc.); it's up to the brewer to experiment with these ratios to see what works best for their beers and their tastes.

CALCIUM LEVELS IN THE MASH

As alluded to, calcium is an essential mineral in beer, but not necessarily for flavor. Calcium in the mash positively affects the enzymes and improves enzymatic function while acting as a yeast nutrient.

Calcium also reacts to oxalic acid, a troublesome organic acid released during mashing. Calcium binds with oxalic acid to form calcium oxalate, aka beer stone, which will precipitate out of the mash. It's important to handle it in the mash so it doesn't form in fermenters or packaging. Beer stone forms a brownish deposit that can harbor bacteria, create nucleation points where CO_2 collects, and cause excessive foaming and gushing. It is tough to remove without harsh acids.

To avoid problems with beer stone and provide yeast health and speedy mash conversion, be sure every mash has at least 50 ppm (mg/L) of calcium (calcium sulfate, calcium chloride, or calcium carbonate).

WATER CHEMISTRY SOFTWARE

If you have your local water report, it's easy to input those numbers into water and mash chemistry software to see how your water alkalinity affects the pH of your beer recipe. It also makes it easy to decide on RO or distilled water dilution ratios or mineral additions. Some can estimate how much acid or minerals are needed to bring your pH into the desired range. Some of the software is free online, while others are spreadsheets that can be downloaded for a small fee. Many recipe software programs and apps also include water chemistry software in their package. BYO

This is an edited excerpt from Keith T. Yager's Unlocking Homebrew: The Four Keys to Tasty Beer *(self-published, 2024).*

BY DREW BEECHUM & DENNY CONN

YEAST ON REPEAT

Methods to reuse yeast for generations

With individual packages of liquid yeast costing over $10 and dried yeast being over $5 in most places, yeast is a good amount of the cost we pay for our brew days.

Photo by E.C. Kraus

Storing yeast under beer for up to a couple of weeks is a great way to keep it ready to be re-pitched between batches.

We have often said that all we do as brewers is set our yeasty friends up for success. We create a sugary, nutritious lagoon of goodness to send well-invigorated cells. They eat to their fill while ignoring the "no swimming for 30 minutes after eating" rule. (Can't you hear your parents stern pleading?) In return for their gluttonous bacchanal, they provide us with a well-attenuated, flavorful beverage filled with Dionysian delights for a weary soul. And like us, at the end of a long day, all our buds want is a good nap before getting back at it.

Let's explore how we provide for our yeast in between their swim meets!

WHY?

We've spent a fair amount of time, both here in this column and in our writings, seminars, internet calls, and podcasting adventures over the years extolling the virtues of vital, healthy yeast. For all of the incredibly stupid, lazy, and lackadaisical things we do as homebrewers, if we just get yeast cells that are raring to go into the waiting wort, good Saint Nicholas will forgive our sins and reward us with a snappy malt beverage.

With the increased availability of a wide range of yeast options to choose from — a near-endless number of strains and multiple form factors, all available at the click of a mouse — it's easy to use a new pack of yeast every time we make a batch of beer, but there are several reasons to save your yeast for another go:

1. Cost: With individual packages of liquid yeast costing over $10 and dried yeast being over $5 in most places, yeast is a good amount of the cost we pay for our brew days. And as much as we scrimp and shave costs on other ingredients, being able to reuse yeast, even once, gives us a heck of a discount. (And have you seen how much yeast you throw away at the end of a batch!?)

2. Yeast Health/Generational Changes: As yeast generations increase (aka the more a culture is re-pitched) there are performance changes. In talking with professional brewers, many believe that yeast cultures begin behaving normal after the first generation. Drew has even found that some firmly believe the classic Wyeast 1056 (American Ale) Chico strain reaches peak performance at around seven re-pitches.

3. Banking: In an era where FoMO (Fear of Missing Out) is a marketing strategy, yeast providers are always rotating available strains. Yeast labs do it for less nefarious reasons than say Disney putting "films into the vault." There are practical reasons for not keeping "all the strains, all the time." But if you want that limited edition strain year-round, you're going to need to work some magic of your own.

4. "House Yeast": Lastly, along with the performance changes that happen, over time yeast strains will drift as repeated brew runs select for new variants with different characteristics that thrive under your brew conditions and practices. Before strict microbiological practices gave rise to the modern world of single-strain brewing, the general philosophy among brewers was "our yeast is our yeast and this is how it tastes." Your mileage on developing a good house strain will no doubt vary as we've both known old timey brewers who disclaim, "I bought yeast once back in Nineteen Dickety Two and just reuse it." Invariably, their beer tastes like it too!

SETTING OUR GOALS

When we go to save a yeast for reuse, what is it that we want to do? To our way of thinking, we want to preserve the generation of fresh and vital yeast (to curry the favor of the beer goddess). Unless we're heading for "house yeast," we want to preserve the strain characteristics that draw us to this particular strain. We want to avoid picking up any off characters. We definitely don't want to do any more work than is necessary! In other words – easy, same, and healthy.

WHEN TO GRAB YOUR YEAST

One thing to consider is the timing of grabbing your yeast slurry for saving. In this time of hop to hell everything, our one consistent rule is to grab your yeast before dry hopping. You don't want hop matter and hop oils to interfere with yeast health and having future flavor impacts. (In fact, this is why many brewers now wait until they do a yeast drop before they add any hops to primary.)

WAYS TO SAVE YOUR YEASTS

The challenge to saving yeast for reuse is that it's a semi-fragile, living culture. It must be tended to — given nutrition and the right environmental conditions to survive and eventually thrive. It's not quite as delicate as the three-day-old thawed fish sitting forgotten in your meat drawer, but it's not far off. Maybe much more like a sourdough starter, but more fragile since we really want certain characters from it, not just "make my bread rise."

So here we present to you, the ways we've saved yeast for reuse. We've ordered these in terms of "value" (a blend of success and ease — again, lazy!). Please note, this doesn't include some techniques like the home drying methods used for preserving kveik strains.

One other note — now that we're entering the very different world from "sanitize the packet, cut, and dump," sanitation at all steps of the way becomes direly important. Even if you perfectly preserve your yeast, preserving bacteria along with it renders your work useless. Once we get into long-term storage, sterilization will become the watchword, but regardless, minimize transfers, minimize dust flow, flame sterilize glass lips, etc. This also includes skipping an oft discussed technique — yeast washing. Neither of us see a practical benefit to it at our level and doing so provides more chance to introduce harm.

Oh, and don't forget, from the moment you pitch the yeast, you should treat your formerly dried yeast as a liquid yeast culture.

1. Immediate Reuse: For us, this is really the way. Instead of saving the yeast in increasingly complicated ways, just reuse the yeast "immediately." In a brewery, this would be a matter of cone-to-cone transfer from a finished batch or using a yeast brink. At our level, it's much more likely that we're reusing fermenters.

We recommend transferring the finished beer, removing the yeast slurry to a cleaned and sanitized jar/growler. Keep it capped with foil while you clean out the fermenter and re-sanitize. Add your wort and pitch the yeast as normal. With a slurry, there's no reason to add all the yeast (unless you're doing a massive beer). Drew generally adds about ⅓ of the yeast cake. If you want precise measurements, Dr. Chris White of White Labs recommends 300 mL per 5 gallons (19 L) to get an appropriate colony going.

While we label this as "immediate," you can save the slurry overnight and pitch it the next day.

If you're a daring Dickety Two brewer, you could go straight into the same fermenter without cleaning and sanitizing, but remember you're going onto a full bed of yeast, dead cells, hop matter, and any other critters that are trapped in the trub or in the carboy on transfer. In general, we just don't like it. (And hey, for once as a homebrewer — you'd be overpitching!)

2. Store under wort/water: The problem with immediate reuse is, well, sometimes you're not ready to re-brew. We've both successfully saved yeast by storing a slurry in mason jars/growlers in a fridge for a couple of weeks. Again, the same rules apply — sanitize everything like you were thinking about performing surgery. Keep the yeast cold and if you put the lid on it, do not tighten so air is able to escape. Alternatively, a lid with an airlock is a really good idea here.

When we first started brewing, the big online debate about saving yeast was "under wort" or "under water." Water proponents felt that it was a better, safer, cleaner medium under which to store the slurry. Wort proponents felt that fermented wort was the natural resting place for yeast to begin with and wouldn't cause osmotic issues with the cells like sitting in pure water. Theoretically, at least, wort provides nutrients for the dormant yeast.

We've tried it both ways and haven't found a great reason to use water, at our level. Instead, just store the yeast under some of the beer it came from and keep moving!

Don't be tempted to rinse your yeast. It's unnecessary and could be detrimental. This is what our good friend and Yeast Whisperer Mark Van Ditta had to say on our website:

"While using a secondary fermentation vessel to prevent autolysis has gone the way of the dodo bird, amateur brewers still cling to yeast rinsing, a practice that is not based on science and provides no microbiological advantage . . . When a brewer rinses yeast with boiled water, he/she removes the protective force field that a yeast culture built for itself, basically opening it up to infection from house microflora while providing zero microbiological advantage. A yeast culture does not need to be kept free from trub and hop particulate matter. It needs to be kept as free from wild microflora as possible because every time a culture is pitched it is an opportunity for microflora other than the culture to replicate . . . If you need further evidence that yeast rinsing is an amateur brewer fabrication that is not based on microbiology, watch how a craft or industrial brewery bottom crops yeast. They either pump it out of the cone into a yeast brink for temporary storage or into a fermentation vessel with fresh wort. I have yet to see a professional brewery rinse yeast with water before re-pitching it."

3. The Everlasting Starter: Another trick we've seen used by abstemious brewers is to treat a slurry (or their starters) as a source for new starters. Again, like our sourdough cousins, we're just keeping something growing continuously by feeding it more wort until it's time to jump up into a starter. If doing this, it'd be recommended to make a larger volume of wort and can it, so you have it on hand and ready when your yeast needs a snack. Much like a regular starter, this won't hold indefinitely!

4. Plating: Now's the time when you get to play full mad scientist. If you want to truly store your yeast in the best condition for more than a few weeks under beer, you'll need to become an amateur microbiologist.

This topic includes way, way too much to cover in the amount of column inches we have here. With a few extra tools (a nichrome loop, a burner, a pressure cooker, plates, growth media, etc.) and a steady and patient hand, it's possible to properly store your favorite yeasts for a near indefinite period in the fridge. Be warned that maintaining a "yeast ranch" is another hobby in and of itself as you periodically replate your cultures onto new plates to ensure your culture's viability.

You can read more about yeast ranching on plates, stabs, and slants in *Yeast* from Brewers Publications. Drew learned from Pierre Rajotte's *First Steps in Yeast Culture*.

Drew ran a little yeast ranch for a few years, but eventually with time and patience running in short supply, the ranch fell to ruin and all those yeastie dogs ran off to the great pasture in the sky.

5. Freezing: What about freezing your yeasts? There are techniques that one can use — blending yeast slurry with glycerol can allow you to safely freeze a strain in small (30- to 50-mL) vials without too much damage to the cells. (Glycerol effectively interrupts the formation of sharp ice crystals that bust open cell walls.) The blend depends on the strength of the glycerol solution.

If you're not storing in a lab freezer — and you're probably not — you should store your tubes in a small cooler to protect the slurry from the warm thawing cycle that most residential freezers perform.

REVITALIZING YOUR YEAST

No matter how you choose to store your yeast, you'll want to make sure they're rip ready to go for the next assignment.

If your slurry is more than a week old, we recommend pitching into a yeast starter to create new cell growth and new energetic yeast. If you're starting from plates/slants/stabs/frozen vials, you should start with a much smaller starter (10-mL for plates/slants/stabs, 250-mL for frozen vials). Let the yeast grow for a few days before moving into your pitchable starter size.

At every step of this process, check your yeast. Does it look normal? Any fuzzy spots? Is the strain growing/fermenting in solution? Is it sluggish? Does the starter smell off? (Reminder, starters smell radically different than beer.) If the culture doesn't seem healthy and ready to go, dump the starter and try again (or use fresh yeast). Don't be penny wise/pound foolish with your beer's yeast. BYO

BY AMY TODD

BENEFIT FROM TEST RESULTS

Quality control fixes

Having a quality control program in your brewery is an excellent way to ensure you're meeting the needs and expectations of your customers. The more you know about your beer, the more you can control — flavor, ingredients, scheduling, even sales. You can use the information you collect to make better decisions about your beer, prioritize your actions, and keep the beer flowing.

This is much easier when things are running smoothly, but what happens when you start getting weird results? How do you determine if there's something wrong with your beer or your equipment? How do you rate the severity of the issue? How do you troubleshoot your test results?

For those of you who don't have a quality program, see my previous column "Vetting Your Brew" (www.byo.com/article/vetting-your-brew-starting-a-quality-control-program).

Before collecting data, make sure you can trust your results. Make sure equipment is working properly by reading all instructions, performing routine maintenance and cleaning, performing calibrations, and using control samples.

When you're ready to start taking measurements, keep documents and data organized and easy to read and reference. This sets the foundation of your quality program. Tracking data and looking at trends lets you know if your beer is within a desired specification range, or if you need to make some tweaks on the next batch.

Next we'll run through the steps to ensure your tests are accurate, using some common equipment every nano should have on hand as examples.

CALIBRATION

Check manufacturer guidelines to find out how, and how often, your lab equipment needs to be calibrated. Keep a log or set an alert in your calendar to keep track. It's easy to forget when something that doesn't need frequent calibration was last done, such as quarterly calibrations on a dissolved oxygen meter.

One often overlooked item in need of calibration is a hydrometer. The easiest way to calibrate a hydrometer is in distilled water at the proper temperature (which varies by hydrometer, so make sure to read instructions that come with your specific hydrometer). The reading in distilled water should be specific gravity 0.000. It's a good idea to have at least two hydrometers in case one breaks. Be sure to record if either reads different than 0.000 — I've seen hydrometers from the same company be off by a factor of 0.4 °Plato (nearly two specific gravity points) when measuring the same sample. Document when you performed these calibrations and what your results were. If one breaks and you know the second one needs a correction factor, you simply correct for the difference in hydrometers.

Other equipment, such as pH meters, need frequent calibration — most manufacturers recommend recalibrating each day a pH meter is used.

EQUIPMENT USE

Once you know your equipment is calibrated, make sure it's being used consistently and correctly by everyone.

Chemical standards with known concentrations can be purchased from lab suppliers to test equipment and proficiency. If you don't have a good control sample, testing the same sample but with different instruments can give you a good idea if you're close to where you should be. You can even partner up with another brewery or

Before collecting data, make sure you can trust your results.

Photo courtesy of Shutterstock.com

Recording test results from every batch is a critical step that may alert you of a rising problem before it becomes significant.

work with a third-party lab to check samples against each other and make sure you're getting the same results on different instruments. The American Society of Brewing Chemists (ASBC) also offers a Laboratory Proficiency Program (www.asbcnet.org/lab/lpp/pages/default.aspx) to ensure accuracy when testing.

Since you use a hydrometer so often in the brewery, take care to ensure proper use. Samples should be taken with liquid that is not carbonated and on an even surface with the hydrometer in the center of the sample, not touching a side of the sample tube. Be sure to measure samples at the recommended temperature for the hydrometer also as measuring very hot or very cold samples can lead to inaccurate results. Density changes based on temperature, and most hydrometers are calibrated to be read at 68° F (20 °C). Some hydrometers come with a thermometer build in to adjust for different temperatures so you'll want to calibrate that portion as well using another thermometer.

When taking pH measurements, make sure your probe is fully submerged in the sample with adequate mixing and check the expiration date of your pH solutions and probe. Most probes on a benchtop meter will last about two years, after which point you only need to replace the probe and not the whole meter. Once opened, pH buffers last roughly two months. Write the date on the bottle when you open it.

REPEATABILITY, ACCURACY, AND PRECISION

Repeatability is the variation between multiple measurements of the same sample. Accuracy is how close the measurement is to the actual value, and precision is how close the measurements are to each other. You can't be more accurate than your equipment or testing method is capable of. Learn the limitations of what you're measuring, the equipment you're using, and how you're measuring it.

When in doubt, double check questionable results. Sometimes testing mistakes happen or you don't get a representative sample. Before dumping a batch of beer or taking drastic measures, double check your results, either yourself or confirming with another brewery or lab, to give you more confidence in your decision on what to do next.

SPECIFICATIONS

Now that you are confident in your equipment, testing method, procedure, and results, how do you know there's a problem with the value you just collected?

Setting minimum and maximum limits on attributes you're able to measure in your brewery allows you to monitor brewing and fermentation consistency. Some specifications are based on regulations, such as ABV. Check with the current TTB regulation on the acceptable range of ABV listed on the package. Your state might have specific tax or labeling regulations based on the ABV as well. Fill levels are also required to be within a specified range of what's stated on the label.

When you're first making a new beer, base the expected values off calculations, or where you anticipate the beer to fall based on previous experiments with your brewing system. If you've brewed a similar style or used the same yeast strain you might have a better idea of where the new one will finish. For the first few you might give a wide range of acceptable values until you're able to dial in the beer and get it right where you want it flavor-wise. The more you brew it, the more data points you collect. Update and adjust this value as you go. As you improve your recipe or invest in new brewing equipment your specifications might change. It doesn't need to be set in stone.

Customers expect a similar flavor profile every time they buy a particular beer. A lot of that consistency has to do with how consistently you brew that beer, how close you are to your measured values such as temperature, volume, pH, starting and final gravity, yeast pitch rates, and more.

As you become more experienced, you'll notice less variation in your data and you'll be more likely to hit your expected values when making a new beer. You might even find more efficient ways to get the same values. You might also notice changing your mash temperature gives your beer a more rounded finish. If that change improves the flavor of your beer, you as the brewer are allowed to make that change. Consistency is important in craft beer, but not to the detriment of the beer! Quality is consistently meeting or exceeding your customers' needs and expectations. If you decide to alter the starting gravity of one of your beers, improve process or flavor, or make another change that meets or exceeds your customers' expectations, you're still getting it right.

Take time to review results, look for trends and make sure the specifications you're brewing towards are realistic. Be firm with your specifications once you set them. Something that falls outside of your specifications shouldn't be released into the marketplace as it is. You might have a range of red, yellow, and green values where green is the ideal range, yellow is still acceptable, but it may trigger an investigation. If something is starting to trend out of spec, you want to catch it before it gets into the red range.

Anything in the red range goes on hold to either be adjusted, if possible, or dumped.

RATE THE SEVERITY

Not all out of spec scenarios are detrimental. Take time to evaluate the risk and decide how quickly this needs to be dealt with. Is there a health issue associated? Health risk factors include things like potential caustic or cleaning solution in beer, exploding cans or bottles, packaging defects, and undeclared allergens. With low- or non-alcoholic beverage you need to closely monitor for potential pathogens.

Is the problem isolated to one batch or is there a potential for others to be affected? Do you need to test other batches to confirm? If you have positive micro hits in a bright tank or a fermenter, you'll want to look at other tanks or packaging lines that beer came in contact with. In this case moving beer could potentially spread contamination, so put tanks on hold until you've found the source or the extent of the problem.

Flavor issues aren't always apparent right away and you might not know if you're going to have issues later on or not. If you distribute your beer (which may not be the case for many nanos), then keeping a beer library, where you store beer until the best-by date is reached allows you to monitor beer that's out in the marketplace. There might be additional testing you need before making decisions on what to do with the beer. Third-party labs can help with testing you're not able to do yourself.

You might have to dump a batch if the flavor is off or there's something you can't fix. Remember that every beer you put out might be someone's first experience with your brand, and you don't want to risk someone having a bad experience and not coming back.

ROOT CAUSE ANALYSIS

Whether you salvaged your beer or dumped it, you'll want to fill out a root cause analysis form (here's a free download: www.shorturl.at/pvyHT) and figure out what happened.

It might be obvious, maybe a mistake was made somewhere along the way, or you might never find the cause. Keep detailed brewing and fermentation notes that you can look through to see what may have happened. Come up with a plan of how you will prevent it from happening again. Maybe there are additional checks and stop points that need to be added to the process.

TROUBLESHOOTING

Here is a very brief look at what troubleshooting might look like. These are not the only causes and effects and by no means an exhaustive list:

Problem	Possible Cause
Inconsistent Starting Gravity	Variation in recipe, ingredient, or brewing process. Make sure any flow meters in use are accurate. Monitor pH in brewing and fermentation.
High Final Gravity	Variation in recipe, ingredients, or brewing process, poor yeast health, improper pitch rate, inaccurate or improper fermentation temperature control. Try cell counting and forced fermentation testing, monitor pH.
Low Final Gravity	Variation in recipe, ingredients, or brewing process, poor yeast health, improper pitch rate, hop creep, wild yeast or bacterial infection, temperature control. Monitor pH.
Inconsistent flavor	All of the above and more!

Quality assurance gives us confidence that our quality requirements will be fulfilled and our equipment is providing us with accurate results. Testing or inspection of desired conditions is our quality control. We can react differently based on what our results are and make changes if needed.

Sometimes troubleshooting involves a brewing problem, and sometimes it's equipment or instruments. This process runs more smoothly when you have confidence in your equipment, process, document control, and testing results as it gives you a better understanding of where to look and how to fix the problem, saving time, energy and money.

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LAST CALL

BY JIM PRESTON

TAP HANDLE MANIA

Whittling a new hobby

I had done some woodcarving off and on since my Boy Scout days, so I figured why not carve a tap handle for each of my brews?

Photo by Jim Preston

Three Game of Thrones*-inspired tap handles (left to right): Highgarden Ale (House of Tyrell), Dragon's Blood Ale (House of Targaryen), and Direwolf Winter Ale (House of Stark).*

I've been brewing off and on since the early 1970s when I was a student at the University of Tennessee in Knoxville. At that time, all that was available to me was unhopped Blue Ribbon Malt Extract (in a big can), plain old table sugar, and baker's yeast (all combined to produce a strange brew). I'd mix the ingredients up in the kitchen of our apartment, then haul it down to our wired storage cubicle in the basement where it would ferment. I also kept my bottled brews there and can remember a bottle bomb or two. I brewed again for about six years in the early 2000s, until we moved to Arizona in 2006. Prior to the move I sold all my equipment because, "I'm sure I'll never do that again."

In 2014 my wife suggested I try brewing again, but to also get a kegerator (three tap) as I had always bottled before and never really enjoyed the work that goes into bottling. And so began my third phase of brewing. I had done some woodcarving off and on since my Boy Scout days, so I figured why not carve a tap handle for each of my brews? I'm retired, what else do I have to do? With that concept in mind, a whole new wing of my homebrewing hobby took flight.

My first beer, and subsequent tap handle, was my Running Rabbit Red — an Irish red ale. With more new beers came the need for more tap handles. Sometimes it was a challenge coming up with a unique carving, but I pushed through. Los Muertos Molé — a Mexican spiced beer with chocolate, cinnamon, chili peppers, and others, for the Mexican Day of the Dead Festival held November 1. Gnarly Gecko Ginger Beer — heavy on the ginger, with a nice bite balanced by a little honey and lemon juice. Kokopelli Kölsch — a crisp German-style ale. Ass Dragon Ale — an American strong ale . . . I came up with concept for the tap handle before I designed the beer. A hard cider with a chip carved handle. Oktigerfest Ale is an Oktoberfest or Märzen ale and the tap handle features Calvin and Hobbes in lederhosen.

When the HBO series *Game of Thrones* was released I decided I had to flex my creativity muscles. Over the next year (2016-ish) I came up with four *Game of Thrones*-inspired beers, each with their own uniquely carved tap handle, which I was quite proud of. #1 Highgarden Ale — a Belgian blond with bitter orange peel and coriander. #2 Direwolf Winter Ale — a Scottish strong ale clocking in at 23 IBUs and 7.6% ABV. #3 Dead Crow Stout — an Irish dry stout with Maris Otter malts, and a nice dry finish clocking in at 35 IBUs and a sessionable 4.3% ABV. And finally, #4 Dragon's Blood Ale — a spiced copper ale with 26 IBUs and an ABV of 6.7%. For those fans of the show, you'll know that Ānogar Zaldrīzes, as it was named in Old Valyria (carefully researched, of course), was said to have contained the blood of dragons as an important ingredient. I tried to duplicate it as closely as possible (a little habanero pepper tincture). Drink like a Targaryen. My favorite tap handle (if you can like one child more than another) is the one for my Dragon's Blood.

I was an extract brewer up until about a year ago, but I'm slowly getting my recipes converted to all-grain for my BIAB (Brew-In-A-Bag) setup, which I'm calling my fourth phase of brewing. But I'm bringing one major aspect of my third phase with me into the era. I'm now 25 tap handles deep, all for different homebrews. And when inspiration strikes, you'll find me out with my whittling knife and a fresh piece of wood to bring a new brainchild to life.

You can find more of my tap handle designs on page 11. BYO