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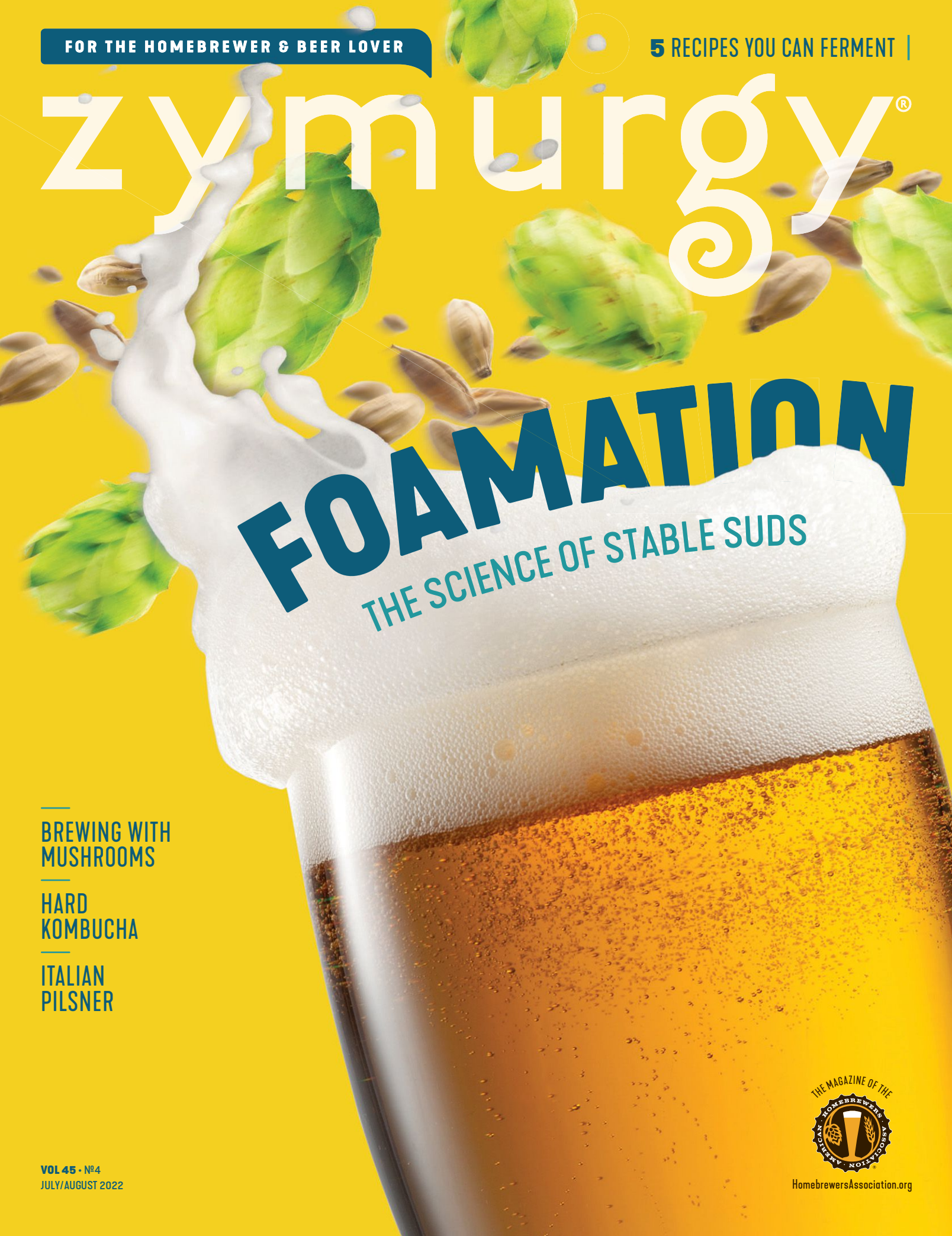

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VOL 45 · №4
JULY/AUGUST 2022

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EDITOR'S Desk

BY DAVE CARPENTER

Big Brew, Small Batch

Photo courtesy of Dave Carpenter

Big Brew, the American Homebrewers Association's annual celebration of National Homebrew Day, took place Saturday, May 7. To celebrate, a couple of Northern Colorado homebrew clubs—Loveland-based Weiz Guys and Fort Collins–based Liquid Poets—teamed up for a joint brew day in a Poet's backyard. The turnout was robust, the weather was splendid, and the beer was delicious and abundant.

I am always thoroughly impressed by those who can just pack up and move their brew rigs to different locations. *How did you get all of that here in one trip?* I think to myself. *You must be spectacularly organized.* I am reminded of Norwegian chef Andreas Viestad, who, on *New Scandinavian Cooking* (check your local PBS listings), assembles his portable kitchen on the tundra and proceeds to cook reindeer or fish or some hard-to-pronounce delicacy involving lingonberries.

I tend to brew by the seat of my pants, so the thought of identifying everything I'd need ahead of time for 5 or 10 gallons in an unfamiliar location terrifies me. Most of my brew days include my reaching for at least one or two tools, not finding them, and then embarking on a scavenger hunt. Even if I knew exactly what I needed and where it all was, I'm not sure all of it would fit in my car, and if it did, where I would sit. But then I remembered the Konami-code power-up of streamlined homebrewing: small-batch brew-in-a-bag.

Small batches have grown in popularity in the last several years, with retailers increasingly offering 1-gallon kits and all-in-one equipment manufacturers making pints-sized batches as easy as pushing a button. And brew-in-a-bag (BIAB) methods empower one to brew all-grain beer with modest equipment. No mash tun? No problem. Marry the small batch to BIAB, and you have an ultra-mobile approach for brewing beer anywhere.

Brewing in a bag is self explanatory, but what exactly makes a batch *small*? If we take 5 gallons as the reference standard, then I suppose anything less than that qualifies, although I wouldn't necessarily consider 4.5 gallons lightweight, and neither would my lower back. One gallon seems to be the most popular contender, but I think 2 gallons still counts.

Thus, I celebrated Big Brew by making 256 fluid ounces of Belgian-style tripel. To keep equipment needs simple, I conducted my BIAB mash without a sparge, so for such a small batch, I could get by with a single 5-gallon stockpot, a mesh brew bag, and a 110-volt induction element. I even went so far as to prepare my brewing liquor ahead of time at home and bring it with me—no messing around with lactic acid or gypsum *in situ*.

After I arrived on site, it was all plug and play. My day was so easy that I had plenty of time to wander around and pester other homebrewers about what they were making. All I had to do during the mash was check the temperature now and then and power on the induction element for a few minutes if it had fallen too much, although the intense midday sun prevented that from being much of an issue.

With no sparge to deal with, "lautering" was as simple as removing the bag of spent grain and suspending it in a small colander above the mash-tun-turned-boil-kettle. Yes, I squeezed the bag.

The boil was uneventful, which is all one could ever really want from a boil. But to make it even less eventful, I decided to hold off on adding candi sugar until fermentation had started, which meant a lower original gravity and thus no need for a yeast starter. A couple of small kettle-hop additions and part of a Whirlfloc later, I was done.

I didn't even chill the thing, opting instead to cover the stockpot and allow the wort to naturally cool before dumping it unceremoniously into a fermenter and pitching a single smack pack of 3787. A couple of days into primary, I dissolved the aforementioned candi sugar in a bit of hot water and added it to the already active fermentation. Two weeks later, I bottled with carbonation drops, the quantum nature of which obviates one's need for a scale.

It was one of the simplest, most slapdash beers I've ever brewed, and I'm pleased to report that it turned out remarkably well. On paper, I broke quite a few rules, including many of my own (and, if you ask certain vocal members of the BIAB community, one of theirs). But, to paraphrase a maxim the internet has variously and inaccurately attributed to Pablo Picasso and His Holiness the 14th Dalai Lama, learning the rules well confers upon one the wisdom to know how to break them.

As a *Zymurgy* reader, you have plenty of opportunities to learn the rules. Next time you brew, ignore a few of them. It'll be OK. It might even be great.

Dave Carpenter is editor-in-chief of Zymurgy.

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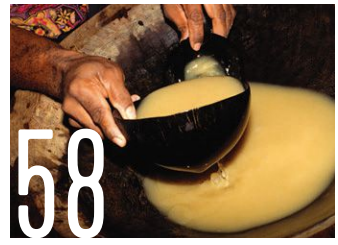

FROM FARMER TO BREWER

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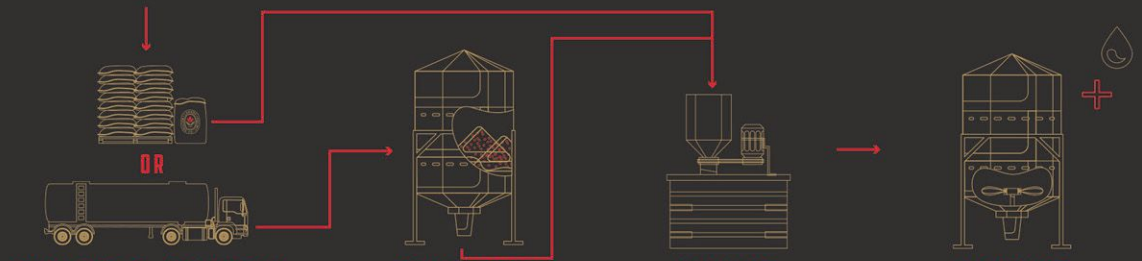

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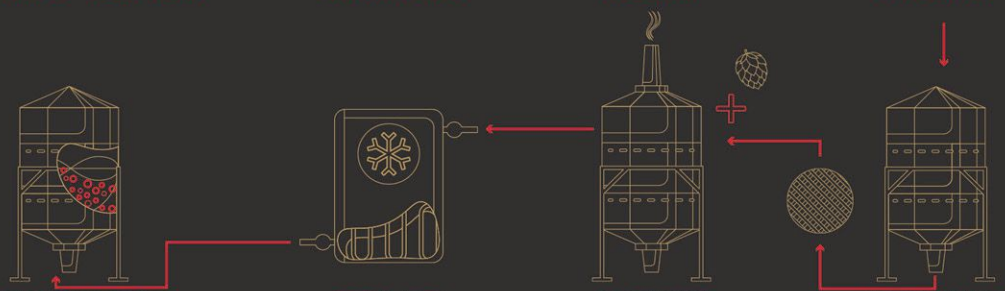

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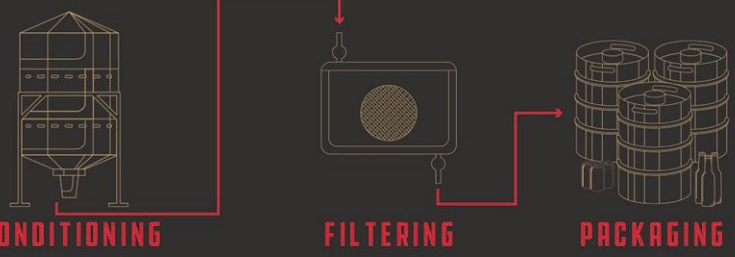

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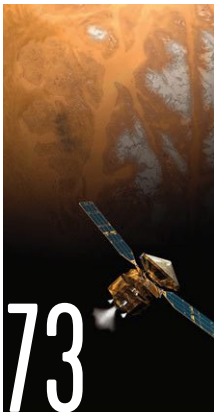

Recipe Guide

Cover
Composite by Jason Smith

Vol 45 • No. 4
July/August 2022

zymurgy

(zī'm ər jē) n: the art and science of fermentation, as in brewing.

ON THE WEB
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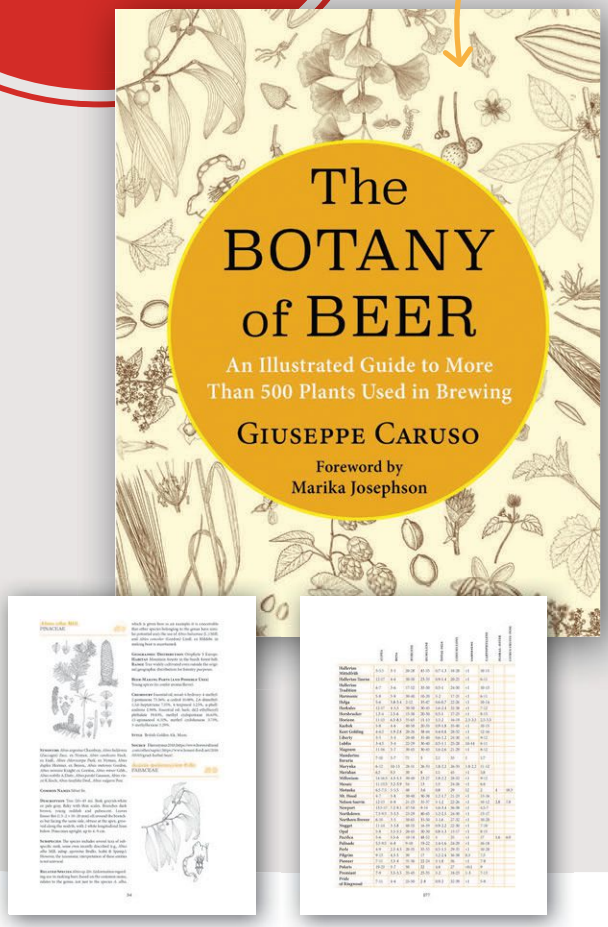

By Guiseppe Caruso

The Botany of Beer is a comprehensive, richly illustrated compendium of the characteristics and properties of plants used in brewing beer around the world. Botanical expert Giuseppe Caruso presents scientifically rigorous descriptions, accompanied by his own hand-drawn ink images, of more than 500 species. For each, he gives the scientific classification, common names, and information about morphology, geographical distribution and habitat, and cultivation range. Caruso provides detailed information about each plant's applications in beer making, including which of its parts are employed, as well as its chemical composition, potential toxicity, and examples of beers and styles in which it is typically used. The book also considers historical uses, aiding brewers who seek to rediscover ancient and early modern concoctions.

This book will appeal to a wide audience, from beer aficionados to botany enthusiasts, providing valuable information for homebrewers and professional beer makers alike. It reveals how botanical knowledge can open new possibilities for today's and tomorrow's brewers.

Giuseppe Caruso teaches forest botany at the Mediterranean University in Reggio Calabria and biology and agricultural biotechnology at the Istituto Tecnico Agrario "V. Emanuele II" in Catanzaro, Italy. He holds a doctorate in environmental and applied botany and researches the flora and vegetation of southern Italy, as well as habitat recovery and restoration processes. He is also a beer expert and taster.

The Botany of Beer is published by Columbia University Press and retails for $34.95.

HOME BREW CON 2022®

JUNE 23–25
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Homebrew Con

We hope to see you in Pittsburgh, Pa., as Homebrew Con™ 2022 gets underway just a few days after this issue of *Zymurgy* goes live. Whether or not you attend, all AHA members can take advantage of the educational sessions that take place during the conference. Session recordings will be available for all members to enjoy a few weeks after Homebrew Con concludes.

We'll have additional coverage of this year's conference in the Sept/Oct 2022 issue of *Zymurgy*, along with our annual feature of gold-medal-winning recipes from the National Homebrew Competition.

Looking ahead to next year, we're pleased to announce that Homebrew Con 2023 will take place June 22–24 at the Town and Country San Diego in San Diego, Calif. Stay tuned for further details in early 2023.

Big Brew 2022

The AHA's annual Big Brew event is our way of celebrating National Homebrew Day, which is observed on May 7. Big Brew is always held on the Saturday before National Homebrew Day, and this year the two happened to fall on the same day.

Big Brew 2022 spanned 51 states and territories and 30 countries, with 887 homebrewers taking part to brew up 6,607 gallons (30,036 liters) of homebrew. Big thanks to all of the participating homebrewers who made Big Brew 2022 a success!

Homebrew Club Insurance

One way the AHA supports homebrew clubs is through the AHA's club insurance program, which offers U.S.-based, AHA-registered homebrew clubs affordable general and liquor liability insurance, as well as an option for directors and officers insurance. Such insurance coverage is typically too expensive for clubs to afford individually, but the AHA works with West's Insurance to collectively offer coverage at a very reasonable price. West's general and liquor liability coverage for clubs costs just $4.40 per club member per year.

To make this insurance even more accessible, the AHA will reimburse a club's general and liquor liability insurance coverage premiums if 75 percent or more of that club's members, as reported to West's Insurance, are also AHA members. AHA members can update their club affiliations in the AHA database by logging into HomebrewersAssociation.org.

In the 2021–2022 enrollment period, 394 clubs obtained coverage through West's Insurance, and the AHA reimbursed premiums for 50 of them. Sixty-two clubs opted to add directors and officers insurance to their policies.

The enrollment period for 2022–2023 club insurance—which covers policyholders from September 1, 2022, to September 1, 2023—is open July 1 through September 1, 2022. Don't miss this opportunity to get your club's insurance premium reimbursed while supporting the AHA at the same time. See HomebrewersAssociation.org for details.

Mead Day

Every year on the first Saturday in August, the AHA celebrates mead, the world's original fermented beverage. Join the fun on August 6 by mixing water, honey, yeast, and more to make a batch of mead. Be sure to watch HomebrewersAssociation.org for more information on meadmaking and for announcements of the official recipes for Mead Day 2022.

Photo © Getty/viennetta (honey)

Competition News

2022 CENTRAL OREGON PRO-AM BREWING CHALLENGE

Central Oregon Homebrewers Organization (COHO) presents the Central Oregon Pro-Am Brewing Challenge, which pairs homebrewers with commercial breweries to craft unique beers and compete for top honors at a people's choice judging.

The Central Oregon Pro-Am Brewing Challenge is open to any Central Oregon resident homebrewer aged 21 or older, and entries are not limited to any particular category or style of beer, within the following guidelines. Entries will not be judged to specific BJCP styles, but rather on their technical merit and appeal for commercial brewing.

Full guidelines can be viewed at the competition website and include the following:

- ❏ Up to three entries may be submitted. It is possible for one brewer to have multiple winning entries.
- ❏ Any style is acceptable; however, process and ingredients should take into account feasibility for commercial brewing. Note: not all breweries can accommodate lagers.
- ❏ A brief description of the beer is required. BJCP style is requested for flighting purposes only, not for judging. A complete printed recipe must be provided.
- ❏ Entrants may designate a charity to receive part of the competition proceeds. Charities should have 501(c)(3) status and a presence in Central Oregon. They must be organized for the public benefit and are subject to approval by the COHO board and the participating brewery.
- ❏ A $10 fee per entry is required.

Participating breweries include Bevel Craft Brewing, Boneyard Beer, Crux Fermentation Project, Deschutes Brewery, Initiative Brewing, Mecca Grade Estate Malt & Tasting Room, Monkless Belgian Ales, Porter Brewing Company, Spider City Brewing, and Wild Ride Brewing. This may be subject to change.

The deadline for registration is July 30, 2022, and beers can be dropped-off (or mailed in) from July 20 to July 30. Judging will be held August 8 by a panel of judges consisting of professional brewers and other beer experts, and participating breweries will choose which homebrewer's winning beer they will brew. Brewing these winning beers will take place from late August through early October as scheduling allows, to be served at the breweries' taprooms and a special Pro-Am People's Choice event held at the Boneyard Pub on November 5.

For full details and rules, visit the competition website page at beerawardsplatform.com/co-pro-am.

ON THE WEB

Find AHA/BJCP Sanctioned Competitions near you!

HomebrewersAssociation.org/aha-events/aha-bjcp-sanctioned-competition

COMPETITION RESOURCES

- Competition Calendar
- Sanctioned Competition Rules
- BJCP Competition Center
- BJCP Style Center
- Request AHA Prize Donation
- Become a Judge

DIRECTOR'S *Cut*

BY JULIA HERZ

Reasons and Rewards of Brewing

Forever on—since September 11, 2013—I am consciously more vulnerable, aware, and raw to the world. Neither because 9/11 is the anniversary of the 2001 terrorist attacks on the United States, nor because 9/11 is the New Year in the Coptic calendar.

September 11 is also the anniversary of the Colorado Front Range floods that tore through my town and backyard in 2013, an event that left me gracious and forever changed. My husband and I became FEMA recipients and had tens of thousands of dollars in losses, but some of our neighbors lost their entire homes. I remain gracious to have only been displaced for a few months. In contrast, others died, more were severely injured, and many were displaced for years.


John Dugans


Andrea Dugans

I recall coming home from work on the evening of September 11, 2013. I drove across a bridge, the one closest to my home. The road attached to that bridge soon would be pummeled and pushed away as the river rose, then swelled over its banks, and spilled across the highway and into our backyard.

Trapped for three days, we watched as houses and cars floated by outside our bedroom window, the water reaching to within 10 feet of our home's foundation. As I type, I am reminded how recovery takes perseverance, diligence, focus, and attention. I am reminded how life goes in cycles, as does grief. I am also reminded how recovery comes in many forms, including, yes, making beer.

Homebrewing helps us feel at home. Homebrewing allows us to give to others.

About six months after the flood, we were back at our house and grateful for services we had taken for granted—power, natural gas, running water. That's when I felt brave enough to reach out to my neighbors, the Dugans. Andrea and John, along with their two sons, had lost their entire home and were looking at years of displacement and rebuilding. They happened to be homebrewers.

I told them it mattered to me to help them, and they could not shake my desire to help until the need was met. Knowing they had lost all their possessions and much of their physical land (the river gutted landscapes and left 10- to 15-foot cliffs where rocks and dirt had once stood), I offered to brew them a beer. Not just any beer, mind you, but one they guided. They picked the recipe, my husband Greg and I purchased the ingredients, and then we came to where they were temporarily staying and brewed.

That day in 2014 was the best brew day I've ever had. First, as you might know when you take an outdoor brew system on the road, one is forced to think like a homebrewer more than ever. "Oh, I forgot the strainer." That's OK. Make do with a colander from the kitchen. Where to rig the hose? Where to place the burner so the wind does not dampen the flame? I love these challenges and see them as opportunities to solve. They help the synapses fire in new ways, you know?

On top of that, *this was the Dugans' brew day.* That gave me so much joy and lessened my feelings of grief and helplessness. Sure, we mere humans cannot control acts of Mother Nature, but heck, a brew day? Hells yes. A we've-got-this feeling took over. We felt safe outside. The sun was nurturing and healing as our faces soaked in the Vitamin D. It helped momentarily erase the weeks, months, and years of digging through rubble and mountains of paperwork everyone was facing. The day was glorious. We saw them smile, and the dark clouds of recent processing and loss lifted, if only for a few hours.

When we were done, we left them with two full 5-gallon carboys to happily ferment in the temporary bedroom in which they were indefinitely living. I knew that looking from across the room at actively fermenting homebrew would be a win in their otherwise overwhelming days. When it came time to package the beer, we gave them two of our Cornelius kegs. When the beer was ready, they served it at a party.

Their first big gathering was at their homesite. It allowed them to showcase the rebuilding effort and reclaim the landscape. It allowed them to celebrate resolve. Afterward, we gave them one of our brew kettles and some extra equipment, so they once again had the basics to brew on their own.

You might share your brew for experiments—split one wort into two or more batches to test an ingredient or process variable. Maybe make something big to age until your newborn reaches drinking age. Or do pen-pal-style beer swaps with someone you met on the AHA Forum.

Maybe you need something to proudly serve at Club Night at Homebrew Con™ (June 23 to 25 in Pittsburgh). Perhaps you brew simply for the sensory reward of tasting something made by your own two hands and to pair it with a proper meal. Whatever the reasons, you get it, and I know you get this story.

So back to the reasons for and rewards of brewing. As brewers, we all look for reasons to make that next batch of beer, mead, cider, or something else. More reasons include an upcoming competition, holiday events, or celebrations like Big Brew, Mead Day, or Learn to Homebrew Day. Homebrew club gatherings with themes? You go! A reason as simple as trying out the latest ingredient or wanting to get something bubbling again in the house always works, too. No matter the reason, making that next batch always needs a *why*.

> “When it came time to package the beer, we gave them two of our Cornelius kegs.

Why set aside the time? Why devote your day? Let us not forget that honoring someone we love is often one of the best and most rewarding reasons to brew.

Julia Herz is executive director of the American Homebrewers Association.

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Skeptical Readers

Dear **Zymurgy**,
After reading Leandro Meiners's and Matias Cavanna's article in the March/April 2022 issue ("Skeptical Brewing 2"), I ended up with a couple of questions on how I, as a homebrewer, would prepare the recommended yeast starter.

I typically make a yeast starter using dried malt extract and water to make a wort with a specific gravity of 1.040 (about 10°P) and then add some yeast nutrient before placing it on a stir plate.

The article suggests I propagate yeast in a wort that has been diluted to 2°P and supplemented with a yeast extract that provides a 100:1 carbon-to-nitrogen ratio. I don't have a lab and was wondering if there is some way to approximate that value.

Thanks,
Dennis Sopcich
Loves Park, Ill.

Leandro Meiners responds: *Looking at the paper cited in the bibliography, we can use Table 1 to see that we would need to supplement the 2°P diluted wort with 9 g/L of yeast extract, assuming it is 2% free amino nitrogen by weight, which seems to be a fair assumption for most commercial yeast extract preparations. It is important to note that the 2°P must be fermentable sugars, so if using dried malt extract, which includes unfermentable sugars, the wort should be diluted to 3.5°P, which should yield approximately 2°P of fermentable sugars. Also, after thoroughly mixing the wort and yeast extract, the solution should be pasteurized before use in the starter.*

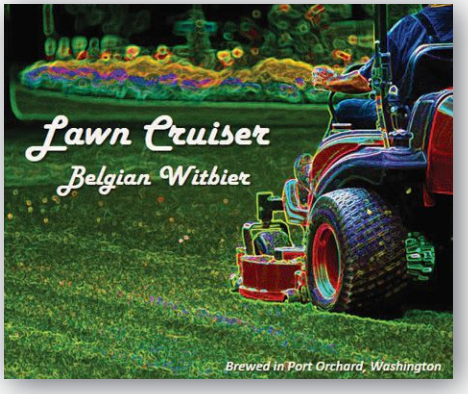
***Dear* Zymurgy,**
Thank you for the article "Skeptical Brewing 2" in the March/April 2022 issue of *Zymurgy*. At the bottom of page 64, there is a practical guide to zinc additions for a 5-gallon homebrew batch. Could you please verify the decimal point is in the correct place? It indicates that 0.017 grams (17 mg) is a target guideline. In the recipes I use here in New Zealand, it is suggested that 1.7 grams of yeast nutrient be used.

Best regards,
Dave Rodley
Nelson, New Zealand

Zymurgy *editor-in-chief Dave Carpenter responds:* *Hi Dave, the article indicates that 0.017 to 0.17 of zinc sulfate heptahydrate be used in a 5-gallon batch. Zinc is but one constituent of commercial yeast nutrient, and only a small fraction of the nutrient you add to your wort is zinc. Amino acids, diammonium phosphate, vitamins, minerals, and other goodies are also in there. Many thanks to Kara Taylor of White Labs for helping us clarify this!*

DEAR *ZYMURGY*
Send your Dear *Zymurgy* letters to **zymurgy@brewersassociation.org**.
Letters may be edited for length and/or clarity.

YOUR HOMEBREW LABELS



I made this label for the Belgian wit I brew for my father-in-law. The beer is good for cruising around the yard on the lawnmower, or sitting on the patio watching someone else do it. (Homebrewer 13 years, AHA member 3 years)

Phillip Saurer
West Sound Brewers
Port Orchard, Wash.

Once a year, I get together with a couple of friends to brew an obnoxiously big beer, and in 2020 we brewed an 18% ABV Samoa cookie–inspired pastry stout. Also, in 2020 during lockdown, I starting sketching and doodling again and had drawn up this goofy picture before we brewed the beer. Once the beer was made and we had named it Monster Merit Badge, we sent my drawing to our friend in Alaska who designs our homebrew club's competition poster every year. She turned the sketch into this fun label for us. She has created many other beer labels for professional brewers and homebrewers alike. You can find her work on Instagram @aithoncreative. After packaging, we dipped the bottles in glittery pink wax because brewing should be fun, even packaging beer. (Homebrewer 10 years, AHA member 10 years)

Tristan McCoy | **Browns Point Homebrew Club** | *Tacoma, Wash.*

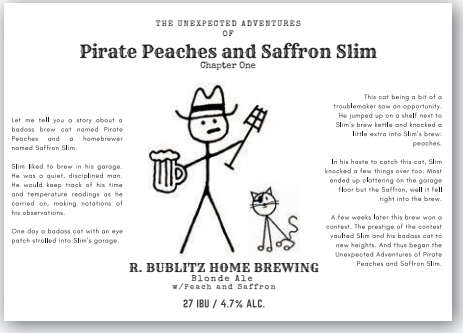
YOUR HOMEBREW LABELS

I was entering the recipe for CommUNITY Lager into BeerSmith and was thinking how the intertwining hops bines might be used to represent what April Dove had in mind. My labels are usually simple and are made on the Avery Label website. I like their film labels because they stand up to being placed in a bucket of ice, and they peel off cleanly. Coming up with a new label is almost as fun as drinking the beer. (Homebrewer 10 years, AHA member 7 years)

Bruce McClure
Michiana Extract and Grain Association - MEGA
New Carlisle, Ind.

My homebrew partner designed this label for our first-ever barrel-aged imperial stout (I have zero drawing skills, even with digital assistance). The barrel had been freshly emptied of a friend's Scotch-inspired whisky. The Muppets theme felt like a reasonable cross between pirates and absurdity. We are all excited to share it in six months or so! (Homebrewer 20 years, AHA member 3 years)

Ian Sahlberg
aecom
Seattle, Wash.



Last year when I was brewing for a homebrew competition, one of my cats, Pirate Peaches, decided to hang out with me during the entire brew day. Of course, as cats like to do, he was curious and tended to cause a little trouble—you know, knocking a few things over—but nothing too major. I decided to use this experience as the backdrop for a fictional story that inspired the name and label for that brew. While I ultimately did not win that contest, it was an exceptionally tasty and refreshing brew! Now, on to "Chapter Two." (Homebrewer 8 years, AHA member 2 years)

Rich Bublitz
The BRiM
Medina, Ohio

I wanted to honor the US Army Infantry Noncommissioned Officer. Every soldier who has ever served in our Army knows where I got the inspiration for this label. "Follow me!!" (Homebrewer 5 years, AHA member 2 years)

Aaron Fulgham
That Dam Brew Club
Rocklin, Calif.

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Do you make custom labels for your homebrew?
Want it featured here in the pages of *Zymurgy* for all to see your work?

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HomebrewersAssociation.org/magazines/submit-bottle-label
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Homebrewing is all about sharing, and we get hoppy when *Zymurgy* readers share their homebrewing and fermentation experiences with us. We'd love to show the AHA community what *your* experience looks like. From 1-gallon batches on the stovetop to 20-gallon brew days on your custom sculpture, we all have fun with family, friends and pets while we make and enjoy our favorite beverage. Show us your brewing/fermentation day, who you brew with, the ingredients you include, what special processes you use, and how you enjoy the final product of beer and beyond.

Upload photos of your homebrew-related fun at
HomebrewersAssociation.org/your-homebrew-experience

John Eischen
(Homebrewer 15 years, AHA member 5 years)
Rochester Area Zymurgy Enthusiasts
Rochester, N.Y.

Thomas Latour
(AHA member 1 year)
Baton Rouge, La.

Brant Colbry
(Homebrewer 10 years, AHA member 5 years)
Lowcountry Libations
Summerville, S.C.

Ryan Holt
(Homebrewer 26 years, AHA member 10 years)
Salem, Ore.

Matt Koval
(Homebrewer 13 years, AHA member 5 years)
Forest Lake, Minn.

KP Glass
(Homebrewer 13 years, AHA member 3 years)
Central Arkansas Fermenters
Cabot, Ark.

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SCAN ME

Hard Kombucha

By Amahl Turczyn

As a follow-up to kombucha article that appeared in the Sept/Oct 2021 issue of *Zymurgy*, we now turn to fermenting kombucha with a higher level of alcohol. These hard beverages are becoming popular with craft breweries and dedicated "kombucheries" alike, as they present a blank canvas on which a limitless number of flavors and colors can be painted.

The basic kombucha process is the same: brew up a batch of tea, sweeten it, introduce it to your symbiotic culture of bacteria and yeast (SCOBY), and the microbes will do the rest. This multi-strain culture includes several forms of acid-producing bacteria, mainly various strains of *Acetobacter*, and as the yeast feeds on the sugar you've provided, they produce CO_2 and ethanol; the acetic bacteria then change the ethanol into acids, producing a tart, sweet, fizzy end product.

1. Fermenting kombucha.

2. This kombucha needs a few more days to acidify.

3. Maintaining correct temperature can be done with a heating pad.

So what if you want to keep some of that ethanol around in your finished beverage? There needs to be an intermediary step that inhibits acetobacter and encourages ethanol-producing yeast. Your SCOBY thrives in an aerobic environment, which is why you cover the fermenter with cheesecloth or a coffee filter; this keeps curious insects out but allows bacteria in the SCOBY to get the oxygen they need to play their acid-producing role.

For hard kombucha, cutting off that air supply is crucial, but since we don't want to injure our SCOBY, we simply make kombucha in the usual fashion until it reaches a palatable balance of sweetness, dryness, and acidity, and then remove the SCOBY. Your SCOBY will be perfectly happy at room temperature, in a covered container, in two cups or so of low-pH (4.3 or lower) kombucha. Once removed, we can proceed with "hardening" the otherwise finished kombucha you've produced.

There is plenty of yeast active in finished kombucha, but it's best to introduce a new slurry of fresh, active yeast to bump up alcohol levels quickly. I like Lalvin ICV D47 for this purpose, as it's slightly fruity (citrus), is alcohol tolerant, produces a full-bodied kombucha, and is relatively clean at its preferred ale temperature range of 59–68°F (15–20°C). It's used by a lot of wine makers for Chardonnay, if that gives you any idea of the expected flavor profile.

Any fresh ale yeast you have on hand will work for hard kombucha, however, so feel free to experiment. For a 2-gallon batch size, one 5-gram packet hydrated per the yeast manufacturer's instructions is sufficient. Once your SCOBY has been removed, you hydrate the dry yeast in 2 ounces (50 mL) of water at 104–109°F (40–43°C) and, if it's been stored correctly, it should start foaming within 10 minutes. Add it to your kombucha, and then prepare your sugar solution—you'll need to feed this yeast to get it to produce the ethanol you're after.

I prefer jun kombucha, which likes honey and oolong tea much better than table sugar and black tea. But remember, we're feeding the D47 we just introduced, not the yeast in the jun SCOBY, so table sugar is just fine. I've experimented with various sugars, including honey, glucose syrup, dextrose powder (pretty much the same thing), and others, but table sugar is the least expensive option here, and I've seen no improvement in yeast performance using simpler or more complex sugars.

As you would to prime beer, dissolve the sugar in water, bring it to a boil, and then cool it to your yeast's fermentation temperature range before stirring it into your kombucha. How much is a matter of preference, but as a rough guide, a pound of added sugar per gallon boosts your already sweetened kombucha to about 15°P (1.061). Depending upon how sweet or how boozy you like your finished hard kombucha, this means you can expect a final alcohol content of about 6% by volume, assuming you'll be bottling it at a medium-sweet gravity of 4°P (1.016).

Once all the sugar is evenly stirred in, you'll need to make sure the fermenter is sealed off from air, preferably with a tight lid and an airlock to allow CO_2 to escape. Then you just need to keep the fermenter in the proper temperature range and wait for the yeast to do its job. Average wait

5. Stash that SCOBY in a clean container with a lid.

6. Cover the SCOBY with fermented kombucha to maintain low pH.

7. If desired, you can rack the kombucha to a separate fermenter for secondary.

4. Be sure to remove that SCOBY before the second ferment.

times for attenuation vary from 7 to 14 days. The same rules for fermenting a sour beer apply here.

Depending on the strain, yeast can be somewhat reluctant to ferment and attenuate strongly and quickly in low-pH environments, so make sure you: use fresh, active yeast; pitch double the amount you'd normally pitch in a beer; be ready to wait longer for full attenuation; and never re-pitch the yeast you use for a sour ferment. Hardy strains such as the D47 mentioned above work well for hard kombucha, but I've also seen favorable results from kveik ale yeast types.

While it isn't completely accurate, a handheld refractometer allows you to monitor fermentation progress without having to pull a full hydrometer sample each time you measure. (See "Revisiting the Refractometer" and "Using a Refractometer" in the Jul/Aug 2017 and Jul/Aug 2013 issues of *Zymurgy*, respectively, for information on adjusting finishing gravity readings using a refractometer.) You can also just dip a sample and taste it; it's fairly obvious when the sugars start to dry out.

8. Dissolve the sugar in boiling water.

Photos courtesy of Amahl Turczyn

Ferment This!

Hard Kombucha Base

Batch volume: 8 liters (2.1 gallons)

FERMENTABLES

400 g	sucrose (table sugar)
40 g	tea leaves (bagged or loose)
2 lb.	(900 g) table sugar (second ferment)

YEAST

1	fully hydrated, active kombucha SCOBY (first ferment)
1 packet	Lalvin D47 dry yeast, hydrated per label instructions (second ferment)

ADDITIONAL ITEMS

8 L	filtered, chlorine-free water
citric or lactic acid as needed to adjust pre-ferment pH	
other flavorings to add at bottling (fruit purees, spices, herbs, etc.), optional	

EQUIPMENT

- pH meter or test strips in the 2.8 to 4.4 range
- 2.5-gallon bucket to use as a fermenter, with lid and airlock for second ferment
- coffee filter or tight-weave cloth and rubber band to cover fermenter for first ferment
- pressure-ready PET bottles

PROCEDURE

Boil water and add tea leaves. Steep 1–5 minutes, depending upon tea variety. Remove tea leaves and stir in sugar until it dissolves. Cover tightly with a lid or plastic wrap and allow to come to room temperature (70–80°F or 21–27°C). Add sweetened tea to sanitized fermenter, then add SCOBY and 2 cups of starter kombucha (or ¼–½ cup distilled vinegar). Stir well, then remove a small sample and test pH. If below 4.5, cover fermenter with screen material and secure with rubber band. Keep fermenter in the correct temperature range for 7 days. Take a small sample, smell, and taste. If you are happy with the flavor and acid balance, use a sanitized funnel to fill your bottles. Don't worry about splashing—*Acetobacter* likes air. Leave about an inch of head space in each bottle. If your tea is still too sweet, ferment a few days more and taste again.

When the first ferment suits your tastes, it's ready to move to the second, anaerobic (alcohol-producing) stage. Remove your SCOBY and keep it in a separate, covered container with 2 cups of the kombucha you just produced. It will continue to produce CO_2, so make sure to burp the lid every couple of days if tightly sealed.

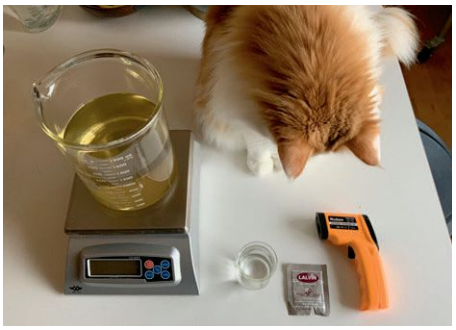
Add 2 lb. (900 g) table sugar to just enough boiling water to completely dissolve all the sugar crystals—about ½ quart (473 mL). Cool to fermentation temperature and add to your fermenter. Cover with lid and airlock for second fermentation. Hydrate your secondary yeast strain using the instructions on the packet, if using dry yeast. When active and foamy, stir into your sweetened kombucha. You should see signs of vigorous fermentation within a couple of hours.

Ferment from 7 to 12 days at around 20°C (68°F). After about a week, or when airlock activity begins to slow, take a small sample. As it attenuates past 5°P (1.020 SG), it should begin to taste less sweet and more balanced with the acids. If you have a pH meter, you can expect your finished kombucha to measure out between 2.5 and 3.5.

If targeting the recommended 4°P (1.016 SG) finishing gravity, 5°P is when you want to add your flavorings. Herbs and spices can be steeped for a day or two and then removed. Fruit nectars or purees can be added now, though your yeast may need an extra day or so to finish at 4°P, depending upon how much sugar your fruit adds.

To carbonate, there's no need to add additional priming sugar—your tea should still have plenty of sucrose. Just keep the bottles at the same temperature for three to seven days, squeezing them gently every day or two to gauge the level of condition. When fully carbonated, transfer to the fridge and enjoy cold. As stated above, it is easy to over-carbonate any kombucha, so drink it fresh! Remember it will still ferment slowly even under refrigeration, so if you forget a six-pack is in there, you may have difficulty getting it into a glass. Fortunately PET bottles can hold a whole lot of pressure, so the risk of bottle bombs is pretty low.

9. Once dissolved, you can add it to the fermenter.



10. Make sure the sugar solution doesn't heat your kombucha over 85˚F (29˚C).

11. Rehydrate your second ferment yeast at the right temperature.

When you've reached your preferred balance of sweet, tart, and alcoholic and are ready to bottle, an optional step is to add any flavorings you think might work well with your boozy tea. Fruit purees, herbs, and spices are all options; I like to combine my affinity for tepache with hard kombucha and add the (well-washed) rind and core of a ripe organic pineapple directly to the fermenter, along with whole allspice berries and a cinnamon stick. (This can actually be done much earlier in the fermentation process, when the specific gravity has fallen to about 10°P. The wine yeast will feast on the sugars from the pineapple and give the batch a really nice floral, fruity, tropical tartness.)

Another option is to add an ounce or two of mango, apricot, or peach nectar to each bottle before filling it the rest of the way with hard kombucha. This gives is a pleasing color, flavor, and often some fruit pulp that will bloom up and mix into solution when you open the carbonated bottle.

For a beautiful red color, try dried hibiscus flowers, fresh raspberries or strawberries, or tart cherry or cranberry concentrate. Coconut, passion fruit, or mango purees add a pleasing tropical dimension. Dried spearmint tends to accentuate the green tea notes, dried chilies can add a spike of heat, and melissa (or lemon balm) contributes an herbal, citrus note.

If you're a jun kombucha fan, experimenting with different varieties of honey is great fun—one of my personal favorites is hard kombucha with orange blossom honey in both the first and second ferments, with a splash of Lebanese orange blossom water mixed in right before bottling. You can usually find this in Middle Eastern or Indian food markets. So many possibilities—commercial hard kombucha companies are a great source of inspiration for new flavor combinations to try. Really, the options are endless.

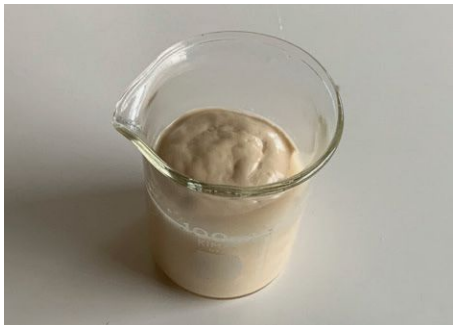
Keep in mind that if using fresh fruit or purees, you may be adding extra sugar, which can throw off the final balance (and, if you're not careful, over-carbonate the finished beverage). You don't have to add any sugar to prime your kombucha—it will carbonate just fine with its own residual sugar, but adding additional sugar at bottling will jumpstart the process.

Bottle the batch in pressure-tolerant screw-top PET bottles, as has been suggested previously for "soft" kombucha. Your yeast may still be quite active once it hits the recommended gravity of 4°P, so bottle conditioning can happen quickly, especially at warm temperatures; plan to give your PET bottles a squeeze every 4 to 6 hours after bottling to see how much pressure is building up. It may take 8 or 12 hours at ambient temperatures, but it's best to stay on top of it so you don't go overboard. It's not uncommon to open an over-carbonated bottle of kombucha—it can be a wild and somewhat unpredictable beverage—so if those PET bottles feel rock hard when you take them out of the fridge, plan on opening them over the sink, just to be safe.

Take your kombucha brewing to the next level and discover a tasty, infinitely variable flavored sparkling beverage that's a delicious alternative to beer. If you have a favorite brewing method or combination of flavors you'd like to share, let us know!

***Amahl Turczyn is associate editor of* Zymurgy.**

12. Your secondary yeast should show signs of activity before you add it.



13. Make sure your brew buddy doesn't find the heating pad.

14. He might not want to leave.

The Origins of Italian Pilsner

By Lorenzo Dabove & Agostino Arioli

Italian Pilsners are catching the attention of beer lovers worldwide, especially in the American beer community. This makes Italian brewers proud, as our country's craft beer movement, born in the second half of the 1990s, owes much of its success to the extraordinary American craft beer renaissance.

The relationship between Italy's craft brewers, Charlie Papazian, and the Brewers Association proved crucial for Italian craft beer pioneers, who learned from their American colleagues how to evolve styles directly inspired by the tradition of other countries—such as Belgium, Germany, and the UK—into original, distinctive beers that would eventually become indigenous styles.

How did Italy go from a ground-zero brewing landscape to one of the leaders in the craft beer revolution in a little over 20 years? The country's adventure with craft beer started with the endeavors of a small group of pioneers, most of whom brewed German-inspired lagers.

As the Italian brewing community started to establish itself and acquire new members, the percentage of lagers produced started decreasing, although a respectable 35 percent of the new beers brewed in 2007 were still bottom fermented (see Table 1). During the following years, lagers would face a dramatic drop with respect to overall production, reaching an all-time low of 9 percent in 2016 and 2017. However, this period proved to be a turning point rather than a dead end for the world of Italian lagers. By 2018, lagers were again on the rise, exceeding 15 percent in 2020 and forecasted to grow even more in the coming years.

TABLE 1: ITALIAN CRAFT ALE AND LAGER PRODUCTION

	Ales	Lagers
2007	64.04%	35.51%
2008	70.74%	28.99%
2009	73.94%	25.53%
2010	75.32%	22.73%
2011	81.02%	17.91%
2012	88.98%	10.50%
2013	85.82%	11.21%
2014	83.85%	10.37%
2015	82.64%	12.52%
2016	90.43%	9.09%
2017	90.69%	9.31%
2018	86.69%	13.11%
2019	85.14%	14.86%
2020	84.34%	15.66%

Source: microbirrifici.org

One of the keys to the growing interest in Italian craft lagers can be traced back to the work of Agostino Arioli, who created Tipopils in 1996, ushering in the idea of a dry-hopped lager. Many other Italian brewers fell in love with brewing "Agostino-style" Pilsner—thirst-quenching and imminently drinkable, while defined by a distinctive flavor and personality. Brewers like Giovanni Campari, a student of Arioli who brewed at Birrificio del Ducato, helped contribute to the growing phenomenon of Italian Pilsner.

Italian beer consumers had begun to evolve from swilling ice-cold mass-market lagers into knowledgeable and demanding connoisseurs. In Italian Pilsner, they found the perfect compromise between a painstakingly constructed craft product and the joy of a carefree drinking experience. The new style began to take off.

Editor's note: *This article originally appeared in the Jan/Feb 2022 issue of* The New Brewer.

BREWING TIPOPILS

By Agostino Arioli

The spirit of Tipopils—recognized as the first example of Italian Pilsner—is one of research and openness in brewing, rather than the desire for the canonization of a new style.

Styles matter for beer competitions, but I believe that if we were able to forget about them while drinking, we'd be happier and more satisfied, opening ourselves up to the physical experience rather than its intellectual counterpart.

Beer—Tipopils especially—is meant for bypassing the brain and reaching directly for the throat, the stomach, the heart, and our emotions: it is a beer meant for pleasure. From this beer, friendships and collaborations have been born, as well as shared adventures, amazing drinking sessions, and moments of sheer joy.

The journey of Tipopils (meaning "type of Pilsner") started in 1996 when the customers at our pub started asking for it by name, instead of asking for "a beer." In 2005, it became the flag bearer for many crusades: showing Italian beer lovers that craft beer didn't necessarily have to be "weird" or brewed with special ingredients or extreme processes, or in a forgotten style. Instead, the very concept of "craft" should be measured through the lenses of intensity, complexity, and uniqueness applied even to the most common of product types.

Italian Pilsner is elegant, yet simple and approachable. It goes with everything and everybody: men, women, food of any kind, situations of all sorts ranging from football matches to hikes, from intense aperitivo sessions to cleansing the palate and mind after a day of tasting wines, spirits, or more demanding beers.

Out of the experience of Tipopils, we chose to specialize in Pilsners as a range, to explore the multiple nuances of variations on the theme. Currently at Birrificio Italiano we brew six different Pilsners: Tipopils; Imperial Pils, our yearly beer brewed within a few hours of harvest of hop plants in Tettnang; Extra Hop, also brewed with fresh hop cones from the harvest; Delia, a low-ABV summer Pilsner using Polaris as an aroma hop; Miss Pepper, sessionable and crisp with added black pepper; Cuvée de Missenhardt, a "white" Pilsner with a percentage of wheat malts; and Sogno Lucido, a higher-ABV "double Pilsner" intensely hopped with noble varieties.

For Tipopils, the fresh aroma is key. Without its distinctive fragrance, Tipo becomes nothing more than a "helles on steroids" and loses its balance, its magic.

From 1996 until 2011, Tipopils was double dry hopped, with hop bags used during primary fermentation and pellets added to the beer during lagering. Currently, Tipopils is dry hopped just once, two weeks into its total lagering time of four weeks, after yeasts and other suspended particles have settled.

Pellets are dissolved in hot water and pumped on top of the tank. During the next few days, they will settle and then be purged exclusively from the bottom of the tank. At Birrificio Italiano, we do not use clarifying agents, filters of any sort, or centrifuges.

The delicate green, slightly citrusy notes that make Tipo what it is come from Spalter Select and Saphir hops. These aromas are key to the balance of Tipopils, but unfortunately, they also are the most ephemeral and fleeting, not lasting longer than a few months. The Tipopils label suggests a best-by date of four-and-a-half months at temperatures below 10°C (50°F).

Every brewer who engages in making a Pilsner should understand the optimal quality window that allows the beer to express its key flavor parameters, which ensure balance and character, in the right way. These parameters are the hop aroma, which must be eminently herbal, although allowing for some minimal citrus nuances; the mouthfeel; and the bitterness. Lagers boasting intensely fruity hops can be great beers, but they are not considered Italian Pilsners or anything similar to Tipopils.

Italian Pilsners should not shout, but whisper. They should focus not on the fresh fruit flavors that are essential in other styles such as IPAs, but rather on the dryness and elegance of traditional European hops. The moderate body, lack of astringency, subtle carbonation, velvety touch, and fleeting sweetness are hallmarks of the style.

The bitterness must be decisive and clean, intense but never lingering in the throat of the drinker. An overpowering, lingering bitterness has no place in a beer as subtle as Italian Pilsner and would quickly fatigue the palate. It took much trial and error to find the perfect amount and quality of bitterness for Tipopils. Today we're using Polaris, one of my favorite aroma hops which, given its high alpha acid content, turns out to be suitable as a bittering variety, too.

Photos © Getty/wuttichok (wood); Getty/rasilija (barley); courtesy of Lorenzo Dabove

Significant validation for bottom-fermented beers came in 2014: for the first time, an artisan who brewed only lagers—Simone Dal Cortivo from the Veneto-based brewery Birrone—was named Brewer of the Year. Three years later, in 2017, the award went to another master of lagers: Piedmont brewer Josif Vezzoli of Birra Elvo.

The path had been established, and many brewers started offering their own take on Italian Pilsners. Each of these beers is substantially different from one another, because, as it is stated, "craft beer is an extension of the personality of the brewer." Many insiders now wish for the style to be officially acknowledged and showcased along with the other indigenous Italian beer style: Italian Grape Ale.

Whether Italian Pilsner officially becomes acknowledged as a style is inconsequential. What matters is that the revolution unleashed by Arioli at Birrificio Italiano in 1996 be considered the birth of a phenomenon.

STYLE SPOTLIGHT

History aside, what constitutes an Italian Pilsner? They are simple beers—any mistakes the brewer makes will be exposed. The beer is a combination of drinkability, character, and a bitterness that is decisive but pleasing. Balance is the key and is the hallmark of the style.

The dry-hopping process and the use of noble European hops are crucial in defining the style. Many American colleagues maintain that Italian Pilsners have a strong, sometimes overpowering hop character for such a light-bodied beer. In a properly executed Italian Pils, the body is indeed not "low" but substantial enough to support the higher hop aroma and flavor. Italian Pilsners are different from the classic versions of the style in that they try to achieve that same level of balance while working with an amplified version of all the elements at play.

The nose in Italian Pilsners boasts fresh floral notes and a pervasive herbal and peppery character. The flavor follows through with those same notes, and a soft mouthfeel leads to a dry, assertive, bitter finish reminiscent of a dandelion. Another critical factor in the sensory description of an Italian Pils is the sharpness in the perception of hops both in aroma and flavor: hop character should be fresh and clean, free of the infusion-like notes that pervade some poorly executed versions. These beers must express crispness to encourage the drinker to ask for a second round.

The popularity of Italian Pilsners is skyrocketing as brewers around the world experiment with the style. Despite the growth of Italian Pilsner, the lack of a style category often forces brewers to enter their beers into generic categories such as Kellerpils, crossing their fingers that the judges will not penalize the beers over the intense perceived bitterness.

If there is anyone who can explain the style in more detail, it is Arioli, who launched a revolution in one of the most social beverages on the planet. See the sidebar for the inspiration behind Tipopils.

Lorenzo Dabove (aka Kuaska) is an Italian beer writer and Agostino Arioli is the founder of Birrificio Italiano in Como, Italy. Together they are among the pioneers of the Italian craft beer movement. ***Zymurgy would like to thank Giovanni Puglisi for translation.***


FOAMATION
THE HOW AND WHY BEHIND BEER FOAM

By Jen Blair

Foam—or head—is a defining feature of beer and one of the characteristics that sets it apart from other carbonated beverages, such as soda and sparkling wine. An attractive cap of foam often communicates freshness and quality to the drinker. Beer foam is frequently evaluated in terms of its color, texture, and retention—that is, the longevity of the foam.

Beer foam is also a matter of cultural distinction. One would expect a thick, fluffy, long-lasting white head of foam on a Weissbier, a thick cap of wet foam atop a Czech lager, or very little head on a cask-conditioned ale served in Southern England (although in Northern England, cask-conditioned ales are typically served with a frothy head due to the use of sparklers).

Several factors affect how foam is formed in beer, from raw ingredients to brewing process to proper beer service. Quality beer foam is often a result of compromise wherein foam-positive and foam-negative components are balanced against the desired finished product. →

HOW FOAM FORMS

Beer foam formation is unique amongst carbonated beverages due to the presence of surface-active molecules, including proteins and iso-alpha acids. The two major factors that affect bubble formation in beer are carbonation level and temperature.[1]

Carbonation Level and Temperature

During production and packaging, most beer is commonly pressurized with CO_2 in closed vessels. This pressurization is important because it allows the beer to become supersaturated with CO_2, which most of us know as carbonation. A defining feature of beer, carbonation affects the mouthfeel, flavor, aroma, and appearance.[2] Higher carbonation results in more foam. A higher temperature also creates more foam because a larger amount of gas escapes the liquid beer.[1]

Nucleation and Bubble Formation

Creating CO_2 bubbles takes work. This work is known as nucleation, which can be intentional or unintentional. Nucleation is the process by which a small defect in the glass or container, preformed microbubble, or insoluble particle acts as the starting point for a CO_2 bubble to form.[1] When a bottle or can of beer is opened, the pressure within the container suddenly drops, which encourages the dissolved CO_2 to escape from the liquid.[3] Most CO_2 escapes as bubbles that form at microscopic cracks or imperfections within the container, known as nucleation sites, at the sides and bottom of the container.[4]

Carbon dioxide gathers at these nucleation sites, and when enough CO_2 gathers at one nucleation site, it forms a bubble.[1] The CO_2 bubble breaks free from the nucleation site and begins rising toward the beer's head. Bubbles formed at the nucleation site become larger and accelerate as they rise because they become nucleation sites themselves.[3] Bubbles expand through the accumulation of more escaping CO_2. Beer bubbles traveling through beer accelerate at about 0.047 miles per hour, which means it would take them about a day to travel one mile.[3] If that sounds slow, it isn't—a beer bubble covers more than 190 times its own diameter in one second.[3]

FOAM STABILITY AND COLLAPSE

The collapse of foam is also an important factor in foam stability. Generally speaking, foam that contains very small bubbles of uniform size will have superior stability to that of foam exhibiting larger and/or irregularly shaped bubbles. Foam with smaller bubbles has better foam stability for two main reasons: more layers and drainage.[1]

Bubbles collapse when gas escapes out of them and into the atmosphere above the glass. When beer bubbles are small, they form more layers at the beer's surface than larger bubbles.[1] Hence, more layers of bubbles to collapse means the foam is more stable for a longer period of time.

More layers of smaller bubbles also mean that the liquid within the foam takes longer to drain back into the beer.[1] Think of moving through a crowd of 3,000 people versus moving through a crowd of 30. Your route is going to be slower and much more circuitous through the larger, more densely packed crowd, so it will take you longer to reach your destination.

DISPROPORTIONATION

Disproportionation is the main process leading to foam collapse. In beer foam, disproportionation occurs when gas passes from small bubbles to neighboring larger bubbles.[1] Disproportionation leads to a reduction in smaller bubbles, which promote foam stability, and an increase in larger bubbles, which reduce foam stability.[1] Disproportionation can be reduced by

lowering the temperature; thus, colder beer will have more stable foam.[1]

Additionally, anything that lowers surface tension will improve foam stability. Surface tension is the tendency of liquids to shrink into the smallest surface area possible.[1] Surface tension is why water will bead into a sphere on a clean surface. Foam on beer, created largely by proteins and iso-alpha acids (discussed below), increases the surface area, which lowers the surface tension.[1] The bubbles contained in 3 centimeters of foam in a glass with a 6-centimeter diameter would cover a total surface area of around 8 square feet![1]

Gas solubility is also an important part of disproportionation. Solubility is the ability of a chemical substance—for our purposes, gas—to dissolve into a liquid and form a solution. Carbon dioxide is fairly soluble, meaning that it dissolves into beer easily. It also means that CO_2 will move out of one bubble into the beer liquid and then be released into an adjacent bubble.[1] The more soluble a gas is, i.e. the better its ability to remain in the liquid, the less stable the foam will be.

On the other hand, the less soluble a gas is, the more it wants to escape from the liquid rather than remain in the liquid and be released into other bubbles.[1] Within beer, insoluble compounds can also be thought of as hydrophobic, which means they seek to escape from water (*hydro* = water, *phobic* = hate). Nitrogen is much less soluble than CO_2 and is a defining characteristic for nitrogenated beers, made famous by Guinness Draught. The presence of nitrogen in beer, even at concentrations far lower than those of CO_2, will have a beneficial impact on foam stability, more so than the impact of temperature.[1]

FOAM STABILIZATION COMPONENTS FROM RAW MATERIALS

Quality foam begins with our raw brewing materials. The two most important components to foam are proteins from grains and iso-alpha acids from hops.

Proteins: Protein Z and LTP1

The two proteins identified a particularly important for foam stabilization are lipid-transfer proteins (LTP) and protein Z.[1] Protein Z is the most abundant protein in beer. It is resistant to proteolytic enzymes during the mash, which means that it resists being broken down from long chains of amino acids into amino acids and other products that yeast uses as nutrients.[1] Protein Z is extracted into the wort during mashing. Liquid-transfer proteins (LTP) move lipids around membranes in barley, and the most important one is LTP1.[1]

Both protein Z and LTP1 are hydrophobic. In beer, these proteins seek out and attach to CO_2, effectively hitching a ride on the CO_2 to the surface of the beer, where they form a protective layer around the CO_2 bubble. LTP1 and protein Z are both water-soluble albumins.[1] Another protein class important to beer foam are hordeins, which are storage proteins in barley that are alcohol soluble.[1] Foam stability is more influenced by the proportion of hordeins and albumins than by the absolute levels of LTP1 or protein Z.[1]

Bittering Acids

Hop-derived iso-alpha acids are the second-most-important foam-stabilizing com-

ponents in beer, after malt-derived proteins.[1] Iso-alpha acids are the principal source of bitterness in beer and derive from the three alpha acids found in hops: humulone, cohumolone, and adhumulone.[2] Iso-alpha acids are formed during the boil when hops are added, and isomerization depends on the length of time hop alpha acids are exposed to high heat in the wort.[2] Thus, the longer hop alpha acids are exposed to the wort boil, the more they are converted into iso-alpha acids. The alpha acids humulone, cohumulone, and adhumulone convert to the iso-alpha acids iso-humulone, iso-cohumulone, and iso-adhumulone, respectively.

Iso-alpha acids have hydrophobic side chains that interact with the hydrophobic regions of malt-derived proteins.[1] The interaction between iso-alpha acids and proteins happens progressively within the bubbles rather than in the liquid portion of the beer.[1] Iso-alpha acids differ in their foam stabilization abilities, with iso-cohumulone being the least effective of the three.[1]

BREWING PROCESSES AFFECTING FOAM

Foam chemistry in beer is still not completely understood; however, there are several processes within malting and brewing that are known to influence foam. In many cases, the processes involve both foam-positive and foam-negative effects. Brewing becomes a balancing act wherein a brewer may sacrifice foam-enhancing actions in one area to maximize the impact of another ingredient or process that is important to the finished beer.

The malt bill in any given beer has the largest impact on foam. As discussed previously, malt and grains give us foam-stabilizing proteins. Additionally, the grist also delivers lipids.[1] Lipids include fats, oils, hormones, and waxes and are insoluble in water. Malted barley usually contains about 3 percent lipids.[1] In beer, lipids compete with proteins and iso-alpha acids, which leads to foam collapse.[1]

While adjuncts such as sugars, syrups, corn, and rice dilute the overall concentration of proteins in a beer, they are also free of lipids.[1] Thus, it is possible for beers with significant levels of adjuncts to still have an acceptable amount of foam. Proteins from wheat have more foam stabilizing properties than proteins derived from barley, so including wheat in a grist will result in better foam retention.[1] Likewise, malts with more melanoidins will also provide better foam stabilization. Black malt provides excellent foam stabilization, but its use is not feasible in many beer styles and its utilization is relatively small even in beer styles that include it.[5]

Malt with high modification levels will have lower foam stability. Modification is the process that occurs during the malting process wherein barley is transformed into malt. In barley, the starches and proteins present are too complex for brewing beer. Thus, the malting process modifies those complex starches and proteins into easier-to-use sugars and smaller protein chains.[2] Hence, highly modified malt means that more of those starches and proteins have been broken down.

Although the science is still being explored, studies have shown that caramel malts, including those long marketed as being good for head retention, tend to behave more like lipids in beer. While there is variability among types of caramel malt, they do contain foam negative materials that have been likened to lipids.[1]

Mashing is the start of the brewing process and is where the crushed grist is mixed with water to create the mash. The goal of the mash is to make as much soluble material as possible available in the wort.[2] There are several different types of mashing regimes from which a brewer may choose depending on their goals.

> “The malt bill in any given beer has the largest impact on foam.

Many of the mashing processes developed as a way to maximize the raw ingredients and malting techniques available historically, such as brewing with corn and rice or grains with low modification levels. Mashing schedules that incorporate a protein rest (95–113°F or 35–45°C) were commonly used when malts weren't well modified. Common reasons to incorporate a protein rest include reducing protein haze, lowering mash and wort viscosity, and increasing free amino nitrogen.[6] Protein rests during mashing are thus foam negative because they break down foam-positive proteins.[7] However, because most commercially available malts today are fully modified, protein rests are largely unnecessary outside of a handful of very specific needs, a few of which are identified above.

Generally speaking, higher mash temperatures, lower pH, and avoiding oxygen pickup during mashing will improve foam quality.[6] It is not settled science why lower mash temperatures are bad for beer foam, but the most viable hypotheses center around enzymatic actions.[1] Minimizing enzymatic actions are also cited for the recommendation that mash pH should be around 5.1.[1] There are several reasons why avoiding oxygen pickup during the mash is beneficial, but for purposes of foam stability, the process kicked off by the introduction of oxygen into wort leads to less protein in the wort.[1]

The gravity of wort is also an important factor for foam stability. Gravity is a measure of the amount of fermentable sugars present during the brewing process. More fermentable sugars mean yeast has more sugar to consume and turn into alcohol. However, yeast becomes stressed at higher alcohol concentrations, which causes it to release foam-damaging proteolytic enzymes and lipids.[1]

Lautering that results in brighter, i.e. clearer, worts will typically have lower levels of lipids in the wort. During wort separation, both polypeptides and lipids will tend to adhere to the spent grains and therefore not transfer into the wort. While polypeptides are foam positive, lipids are foam negative; thus, clearer wort translates into a net win for foam stability.[1]

The boil is another step in the process where there are positive and negative effects on foam. During the boil, foam-positive proteins become denatured, which means the hydrophobic regions are exposed.[1] Exposed hydrophobic regions lead to better foam formation and stability potential. However, because these exposed regions are hydrophobic, their preference is to precipitate out of the wort. Many proteins are therefore lost to the hot break and trub. On the other hand, boiling is where isomerization of hop alpha acids occurs, which,

as discussed above, is also an important step for foam formation and stabilization. Lipids, which are foam negative in the presence of proteins and iso-alpha acids,[1] are precipitated during the boil through the hot break and left behind. Overall, longer boils are detrimental to foam stability due to the denaturing and precipitation of important foam proteins.[1]

Fermentation is also a balancing act when it comes to foam. The healthier the yeast is during fermentation, the better the beer foam will be, mainly due to the absence of foam-negative actions that unhealthy yeast creates, such as the release of proteolytic enzymes and autolysis products discussed above.[1] There are multiple foam-negative creations during fermentation. Ethanol, the creation of which is one of the main goals of fermentation, is foam negative. The higher the ethanol level of a beer, the more it will have a negative impact on foam. Fatty acids produced by yeast during fermentation are also foam negative.[1] Lower fermentation temperature is also better for foam due to improved yeast health and reduction of exogenous proteases, which break down storage proteins such as LTP1.[1]

BEER SERVICE

We haven't come all this way to preserve excellent foam to have it ruined by serving beer in dirty glassware.

As discussed previously, nucleation and carbon dioxide are important factors for bubbles to form into foam. For glassware, nucleation sites can be intentional or unintentional. Intentional nucleation is not uncommon in the beer world, particularly for craft brewers. Nucleation sites are etched into the base of specialty glassware to create a space for CO_2 bubbles to form. Nucleation sites also create beading, which is the continuous rise of bubbles in the glass of beer, which has the effect of continuously replenishing the head.[1]

Unintentional nucleation sites arise when glassware is not properly cleaned. These sites are typically belied by CO_2 bubbles forming on insoluble particles on glassware, such as bits of food or other detritus or by fats that escaped the cleaning process, such as lip balm or oils from hands. The presence of bubbles clinging to the sides of a glass indicates that the glass cleaning process was not thorough enough. Detergents also act similarly to lipids (fats) in that they compete with protein-induced foam formation and thus negatively affect foam stability.[1]

To ensure glassware is clean enough for service, select detergents that fully rinse

away, and inspect each glass prior to pouring beer for evidence of lip balm, visible fingerprints, or food on the exterior and interior. Giving the glass a quick cold-water rinse will also help wash away any residual detergent or lingering particles—glass rinsers for home use are relatively inexpensive and easy to install. When rinsing glassware, observe whether the water is sheeting, i.e. rinsing evenly, or whether it is forming droplets or webbing, which indicate residue or particles.[8]

Glassware shape will also affect foam formation largely due to the surface area available. A glass with a narrow opening will have a smaller surface area than a glass with a larger opening.[1] The shape will also impact drainage: beer contained in the foam will drain much quicker in a Shaker pint than in a tulip glass.[1]

SUMMARY

Many factors influence the formation and stability of foam in beer, from ingredients chosen to process decisions to service. Foam-positive components include iso-alpha acids from hops, proteins from malt and grains, gas composition from carbon dioxide and nitrogen, and carbonation level. Foam-negative components include lipids, ethanol, enzymatic yeast activity, and excessively modified malt. Oftentimes, foam formation is a case of one step forward and two steps back—many ingredients and processes involve both foam-positive and foam-negative results given that there are nearly limitless parameters for achieving the final desired beer result.

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CAMELBAK
CYCONE
COLORADO

Mushrooms

FORAGING & BREWING TIPS

By Ryan Pachmayer

It's common to find mushrooms in a pasta dish, on a pizza, or accompanying a steak. But there's another place where mushrooms can really shine: in beer. The umami components that are so desirable in food can sometimes be present, but more common are rich, earthy, nutty flavors that can be incorporated into a beer, helping to subtly elevate the final result.

On top of adding a new twist to a specific beer, mushrooms can be found for most of the year all around North America. Foraging these mushrooms can be a great way to enjoy the outdoors and learn a new hobby. It's easier to get started than many assume.

Getting Started

If you're going to consume a wild mushroom, being able to identify it with certainty is a requirement. Much has been made about deadly mushrooms, and while some species do have truly deadly lookalikes that you need to be very careful to avoid, it is far more likely that you'll spend an uncomfortable day in the bathroom or potentially a visit to the emergency room if you don't take the time to accurately identify what you've found before consuming.

Danger and The Golden Rule

Ellen Zachos is the author of *The Backyard Forager*, among other books. Her ninth book, geared towards beginner foragers, will be out this year. Ellen says, "Never put anything in your mouth if you're not 100 percent sure what it is. (This is good advice for life, not just mushrooms.)" Ellen has passed up many delicious species because she wasn't 100 percent sure of their identities. She says, "If this happens to you, consider it a learning experience. Go home, open your books (or your computer), and learn everything you can about what you

→

Luke Smith of Coda Brewing Company holding a porcini mushroom.

Ellen Zachos with a fantastic Hen of the Woods haul.

Guidebooks to Mushrooms

Much like with brewing advice, in mushroom foraging the source is of utmost importance if you want reliable, factual information. Below is a list of quality guides, broken down by geography. A special thanks to Michael Baker and Clayton Hanes for helping me curate this list.

MIDWEST

- *Mushrooms of the Upper Midwest: A Simple Guide to Common Mushrooms* by Teresa Marone
- *Edible Wild Mushrooms of Illinois and Surrounding States* by Joe McFarland
- *Mushrooms of the Midwest* by Michael Kuo

NORTHEAST AND MID-ATLANTIC

- *Mushrooms of the Northeast: A Simple Guide to Common Mushrooms* by Teresa Marrone
- *Mushrooms of the Northeastern US and Eastern Canada* by Timothy Baroni
- *Field Guide to Wild Mushrooms of Pennsylvania and the Mid-Atlantic* by Bill Russell
- *Missouri's Wild Mushrooms* by Maxine Stone

PACIFIC NORTHWEST

- *Mushrooms of the Pacific Northwest* by Steve Trudell
- *Mushrooms of the Northwest: A Simple Guide to Common Mushrooms* by Teresa Marrone
- *Foraging Mushrooms Washington* by Jim Meuninck
- *Mushrooms of the Redwood Coast* by Noah Siegel

SOUTH

- *Mushrooms of the Southeast* by Todd Elliott
- *Mushrooms of the Georgia Piedmont and Southern Appalachians* by Mary Woehrel
- *Mushrooms of the Gulf Coast States* by Alan Bessette
- *Mushrooms of West Virginia and the Central Appalachians* by William Roody

WESTERN

- *Mushrooms of the Rocky Mountain Region* by Vera Evenson
- *The Essential Guide to Rocky Mountain Mushrooms by Habitat* by Cathy Cripps
- *All That the Rain Promises and More…* by David Arora
- *Burn Morel Mushroom Guide* by Modern-Forager.com – Covers 11 western states, very helpful for morels that are found specifically the year after a forest fire.

Ellen Zachos has an assortment of mushroom articles on her website, backyardforager.com, with topics including beginner varieties, preservation, tools of the trade and more.

just saw. Next time, you'll be better prepared." Ellen also offers a few words on safety. "No mushroom is toxic to touch, but there are fungi that will make you sick (or worse) if you eat them, and it's not worth taking a chance."

Resources

Using field guides is essential. Michael Baker, who runs a Midwestern foraging Instagram channel under the handle @edible_illinois, says that any time a guide can be found for your specific state, you should start there. He also says that many guides can leave a bit to be desired, so the best thing to do is to use a variety of resources. Foraging guides can be a little intimidating at first—they'll use the genus and species names for mushrooms (such as *Lentinus edodes*), whereas for simplicity's sake, I'm using the common names in this article (shiitake in that example). It can help a lot to break a foraging book down into multiple sections, and start by focusing on a species that is common and easy to identify, before working your way into identifying more complex types.

If you don't have any experienced foraging friends to go hunting with, looking into a local mycology group can be a good idea, too. These are often affiliated with local botanic gardens and museums. These groups frequently lead outdoor foraging walks during the picking season where you can learn from some high-level experts.

Another great resource can be found in the Facebook and Reddit identification groups, especially those with clear identification leadership that sometimes even includes respected authors. These groups usually have strict rules that users have to follow when posting photos of their mushroom finds, including multiple clear photos of the specimen, a general area and elevation where it was found, and what it may have been growing on (e.g. a dead cottonwood tree). Just like the foraging guidebooks, look for a group that is local to you, so that the information is relevant and accurate.

There are also mushroom festivals, such as the National Morel Mushroom Festival in Boyne City, Mich., or the Telluride Mushroom Festival in Colorado. These festivals are magnets for foraging experts, and free identification tables and various classes and foraging walks are frequently offered.

One group of resources to avoid, or to use strictly for ideas, are phone identification apps. These apps have you take photos of a mushroom and the system will tell you

Photos courtesy of Ryan Puchmayer, Cuda Brewing Co.; Luke Smith

what it believes you have. In my experience, these are frequently inaccurate, but I've used them with friends as a source of foraging entertainment at times.

The nice thing about mushroom foraging is that you can always take photos of a specimen and work on identifying it later. Even highly skilled foragers are constantly discovering types of mushrooms that are new to them.

Sustainability and Access

A general rule in foraging is to only pick what you'll use. For many plants in the wild, there is a real danger in over-picking, which can inhibit future growth and affect the native animals that rely on them. With mushrooms, it's less about sustainability than it is about not being wasteful and making it more difficult than it needs to be for the next human who comes across the area.

Mushrooms aren't negatively affected by picking too many, or by pulling them out with your hands instead of cutting them at the base (my preference depends on the type of mushroom, what it's growing on, and how much of it there is). However, you do need to be careful about where you're stepping and what type of damage you're doing to the surrounding environment when mushroom hunting, particularly in fragile high-elevation areas and off the beaten path.

Access, however, is an issue that you need to be very aware of when foraging. It is clearly illegal to forage in plenty of places, and there is strict enforcement in some of the more attractive locations. National Forests can require permits, and you often need to visit ranger stations in person to obtain these permits. These can sometimes be inconveniently located and keep inconvenient hours, but it's critical to obtain a permit when required. Permits are usually cheap, rangers will often give you a map of places you can and can't go, and you'll be doing your part to ensure future access to the area.

In between the clearly illegal and the legal places to forage mushrooms is a vast gray area where it's unclear if foraging is OK or not. Use common sense in these places, figure out who manages the land you plan to visit, and make every effort to contact an authority to find out if it's allowed or not.

Beginner Varieties

It's best to start by looking for easy-to-identify varieties in your area.

A pint of Chanterelle De Garde next to a pile of its eponymous mushroom.

Brew This!

Coda Brewing Co's Chanterelle De Garde

Recipe courtesy of Luke Smith.

Luke Smith has always used fresh mushrooms in the boil, so he doesn't have to worry about wild yeast or bacteria. He uses a nylon bag to hold all the mushrooms in the kettle so that they don't clog his heat exchanger. Luke recommends sitting on a few bottles for a year to be rewarded with amazing notes of dried fig, plum, apricot, and Big League Chew bubblegum.

In Colorado, wild chanterelles are only foraged once a year in late summer to early autumn. If you can't find enough in your local area, you can order them from the Pacific Northwest fresh during the fall.

Batch volume:	5 US gal. (18.9 L)
Original gravity:	1.062 (15.2°P)
Final gravity:	1.013 (3.3°P)
Efficiency:	72%
Bitterness:	23 IBU
Color:	9 SRM
Alcohol:	6.5% by volume

MALTS

5.5 lb.	(2.5 kg) Weyermann Pilsner malt
4 lb.	(1.8 kg) Weyermann Vienna malt
1.5 lb.	(680 g) Weyermann Munich I malt
12 oz.	(340 g) Dingemans Biscuit malt
1 oz.	(28 g) chocolate malt

HOPS

0.4 oz.	(11g) Columbus @ 60 min
1 oz.	(28 g) Tettnang @ 10 min

YEAST

White Labs WLP029 German Ale

ADDITIONAL ITEMS

1 oz.	(28 g) chanterelle mushrooms @ 60 min
1 oz.	(28 g) chanterelle mushrooms @ 30 min
3 oz.	(85 g) chanterelle mushrooms @ 15 min
3 oz.	(86 g) chanterelle mushrooms, whirlpool 30 min

BREWING NOTES

Mash at 152°F (67°C) for 1 hour. Knockout at 56°F (13°C) and ferment at 58°F (14°C) for 3 weeks or until complete.

The author and Nathan Rooen after a successful porcini hunt.


Sliced porcini dehydrating naturally in the dry Rocky Mountain air.

Local resources will help you figure out what beginner varieties are near you. By me, in and around Denver, Colo., oysters, morels, porcini and chanterelles are pretty easy to identify and have few, if any, lookalikes. Michael Baker mentions pheasantback, chicken-of-the-woods, hen-of-the-woods, and blewits as easily identifiable Midwestern mushrooms.

Quick Tastes

Once you've identified what you have—with certainty—as an edible type of mushroom, the first thing I recommend doing is a quick, simple sauté to try it. Clean the mushroom and remove any dirt or other undesirable material; I usually use a painter's brush. The degree to which you need to clean your mushrooms is essentially a personal choice. There may even be bugs in some mushrooms! But if that freaks you out, you can cut off bug-ridden parts or do a quick soak in salt water. Just be sure to dry with a paper towel and avoid letting them get mushy.

My basic recipe for any mushroom I'm going to eat for the first time is to put a little oil into a skillet on medium heat, add thinly sliced mushrooms, spread apart so they don't steam, lightly salt and pepper them and cook all of the water out (you'll hear the difference between water cooking off and mushrooms cooking) and then finish with a touch of butter in the pan. That's it! It lets me taste the flavors of the mushroom and get to know what it may or may not work with, incorporated into a dish or even a beer. Future iterations might include a red wine, fruited liqueur or imperial stout reduction, freshly sliced roasted garlic, or sautéed onions.

Storing Mushrooms

Different varieties can last different lengths of time. I'd recommend storing most mushrooms in the refrigerator, in an open-air type of bag, or in a paper-towel-lined, sealed bag. You want to avoid their becoming mushy or moldy.

I personally try to use all of the mushrooms I plan to eat fresh within 48 hours, and then dehydrate the rest. Here in the dry Rocky Mountains, you can dry mushrooms outside by slicing them thin and using the warm sun and air flow to dry them out. Household dehydrators are very effective too, and many ovens can be used on the lowest setting with the door cracked (in a safe environment) to dehydrate mushrooms. Dehydrated mushrooms can be ground into powder on demand and used

to liven soup bases, stews, and sauces. Mushroom broth from wild mushrooms can be richer than an expensive beef bone broth. I regularly make gallons of mushroom broth and freeze them in quarts to use as needed.

Brewing with Mushrooms

While many people find mushrooms and beer delicious, few find the thought of drinking a mushroom beer particularly appealing. However, when incorporated into the right beer, it can be a wonderful addition. Just as coriander and black pepper can play well with the right Belgian yeast, the earthy, nutty flavors in some mushrooms can really complement the malt, hops, and yeast in beer.

Incorporating mushrooms into beer leaves you with decisions between using fresh or dry mushrooms, and adding them during the boil or in the fermenter.

Fresh mushrooms require the least preparation, they are easily puréed, and they may impart a slightly more flavorful taste to the beer. The downside is that they need to be used right away, and since fresh mushrooms contain a high percentage of water, it requires a lot of material in your kettle or fermenter. They also harbor a great deal of yeast and bacteria, which can be of particular concern if you're adding it to the fermenter. For those reasons, they're best added to the boil kettle or to a beer that is going to be consumed fresh, on draft.

Dehydrated mushrooms store practically forever in a sealed jar. They can be ground into powder, they're easy to soak in vodka to sanitize for secondary fermentation, and you have more control over adding additional mushrooms in the fermenter to suit your taste, as I do with my Morel Helles recipe. While both commercial beers in this article use fresh mushrooms, I personally prefer using mushrooms that I've dehydrated.

The amount of mushroom you use is difficult to determine, but 8 ounces to 4 pounds of fresh, or 2 to 12 ounces of dry is a good place to start. Over several brews with mushrooms, I've estimated that you need about five times more fresh mushrooms as you would dried in a recipe.

The specific base beer that you brew will also have affect the amount of mushrooms that you need to add. In my Morel Helles, I use 3 ounces of dried mushrooms. If I were to brew a strong, malty doppelbock instead, I would probably start by doubling the amount of mushrooms that I use and

Morel Helles

Recipe courtesy of Ryan Pachmayer.

Morels are fairly rare where I'm at in Colorado and they aren't really able to be grown commercially, so most years I won't have enough to make this beer. However, when we get the rare surplus of morels, this is an absolutely stunning beer. The result is a dry, refreshing traditional German Hellesbier with the added richness from the morels. The mushrooms add hints of maple syrup and a light earthiness that complements the noble hops. During a poor morel spring and/or a good porcini summer, porcini would be my substitute mushroom in this beer.

Feel free to make this beer your own by substituting your favorite German Pilsner malt and noble hops at will. You can adjust the fermentation profile, particularly if you're using a different lager yeast strain, but I find the most important aspect of helles fermentation to be starting and keeping the beer cold for the majority of its fermentation. As such, I keep it at 50°F (10°C) for at least seven days, even if I'm doing a diacetyl rest.

While I usually make my house Helles closer to 24 IBUs, I dial the bitterness back for the morel version to really let the mushroom flavor come through.

I conduct a step mash for this beer instead of a decoction, as I'm less worried about the beer not being rich enough with the addition of the mushrooms. If you are unable to do a step mash, I would suggest mashing at 147°F (64°C) for 60 minutes. You want a very well-attenuated Helles, otherwise it can come across as cloying. It's light, clean and refreshing, while still presenting itself as malty due to the moderate, clean bittering hops and the flavorful European Pilsner malt. Up to 10% Vienna malt can be added to enrich the malt profile, but I would avoid crystal malts in this beer.

Batch volume: 5 US gal. (18.9 L)
Original gravity: 1.047 (11.7°P)
Final gravity: 1.008 (2.1°P)
Bitterness: 20 IBU
Color: 3 SRM
Alcohol: 5% by volume

MALTS

9 lb. (4.1 kg) Weyermann Barke Pilsner malt

HOPS

1.25 oz. (35 g) Spalt, 4.5% a.a. @ 60 min

YEAST

2 sachets Fermentis SafLager W-34/70

ADDITIONAL ITEMS

2 oz. (57 g) dried morel mushrooms @ 10 min

BREWING NOTES

Step mash using a Hochkurz regimen of 144°F (62°C) for 40 minutes, 160°F (71°C) for 35 minutes, and 169°F (76°C) for 10 minutes. Ferment at 50°F (10°C) for 14 to 17 days until fermentation is complete and the beer passes a diacetyl test. Transfer to a purged secondary container that contains 2 oz. (57 g) of dried morel mushrooms. Over three days, lower the temperature to 40°F (4°C) and hold for another five days. Then lower the temperature to 33°F (1°C) and lager for 3–6 weeks.

Brew This!

Mobcraft's Shiitake Brown Ale

Recipe courtesy of Andrew Gierczak.

This beer has its best flavor when fresh, so it's best enjoyed as soon as possible. Kegging and serving on draught is recommended to maintain the flavor of this beer.

Batch volume:	5 US gal. (18.9 L)
Original gravity:	1.055 (13.5°P)
Final gravity:	1.010 (2.5°P)
Bitterness:	20 IBU
Color:	30 SRM
Alcohol:	5.9% by volume

MALTS & ADJUNCTS

8.5 lb. (3.9 kg) pale malt
1.2 lb. (500 g) Briess Victory Malt
0.6 lb. (270 g) Briess Midnight Wheat malt
0.6 lb. (270 g) caramel malt, 60°L
0.6 lb. (270 g) maltodextrin
0.6 lb. (270 g) lactose
0.3 lb. (135 g) Briess Carapils

HOPS

0.5 oz. (14 g) Nugget, 12% a.a. @ 60 min

YEAST

Fermentis SafAle US-05

ADDITIONAL ITEMS

1.5–2 lb. (680–900 g) fresh shiitake mushrooms, pureed, in secondary

BREWING NOTES

Mash at 155°F (68°C) for 60 minutes. Boil 90 minutes. Ferment as you would a standard American ale. When fermentation is complete (i.e., specific gravity reading remains constant for 3 to 4 days in a row), add pureed mushrooms to the beer and allow to infuse for 24 to 48 hours. Once infusion is complete and gravity stops dropping, crash cool and keg or bottle as normal.

then adding more to taste. I would, however, recommend starting with a lighter base style, as it will be easier to get the mushroom flavor to come through in the finished beer.

The type of mushroom that you use plays an important role as well. They impart different flavors. Morels impart syrupy richness, whereas oysters have a mild sweetness. Porcini lend a distinct, sophisticated spice flavor and chanterelles offer a strong fruitiness. Try to identify one or two main flavors from the mushroom and pair that variety with a complementary base beer.

Other Mushroom Sources

Sometimes you'll have a really poor mushroom hunting season, especially in dry climates. Other times, you may want to brew a mushroom beer in the off season, or brew with a specific variety of mushrooms that aren't found in your area. During those times, you can look elsewhere for mushrooms.

Local farmers markets often have locally cultivated varieties, and sometimes nationally foraged ones too. While the quality is often very high, the downside is that they are usually expensive. Online mushroom marketplaces exist as well, and they are another good option. Specialty and Asian grocers are more likely to have numerous desirable mushroom varieties and they can sometimes be more affordable, though the quality may be less than that of a local grower, so be especially choosy when shopping at the grocers.

You can also grow your own mushrooms. A good way to start is to order a mushroom-growing kit from a reputable company. When you become more experienced, you can look at inoculating grow media on your own. Andrew Gierczak, cofounder of MobCraft Beer, with locations in Milwaukee and Denver, started cultivating oyster mushrooms, with the hope of eventually getting them to feed on the brewery's spent grain. The pandemic unfortunately derailed that project as priorities necessarily shifted, but he's hopeful to continue in the future.

Ryan Pachmayer is the head brewer at the Yak and Yeti Restaurant and Brewpub in Arvada, Colo. He is also a BJCP Certified beer judge. He can be reached at ryan@puzzah.com.

Photo courtesy of Ellen Zachos

DUDE, LET'S START A BREWERY!

"I WAS ON THE PHONE EVERY DAY TALKING TO BANKERS, TRYING TO CONVINCE THEM THAT IT WAS A GOOD IDEA TO OPEN A BREWERY DURING THE PANDEMIC.

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AARON JUSTUS
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Season 2, Episode 23

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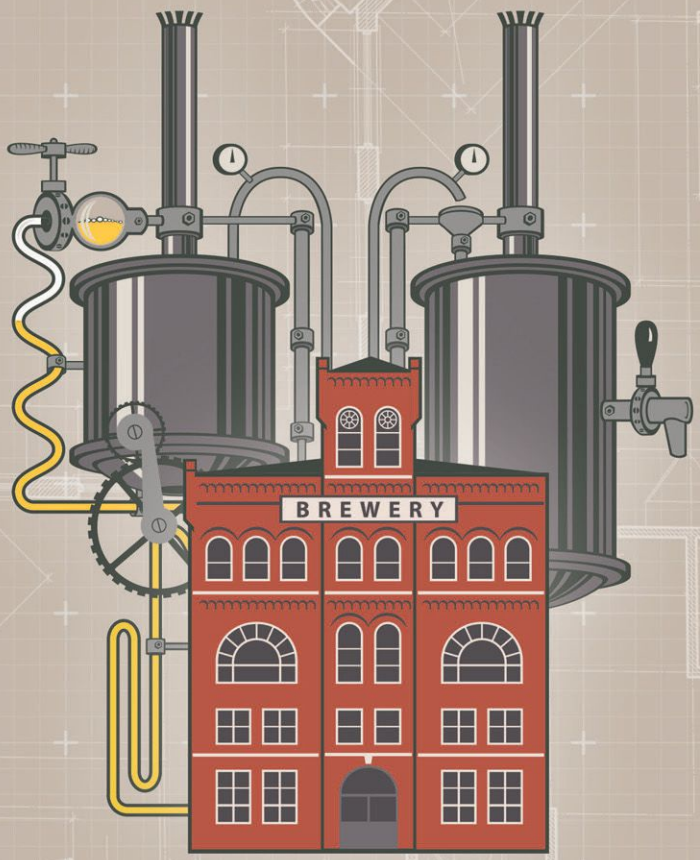

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Editor's note:
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COLOR CALCULATIONS AND MEASUREMENTS

PART 3: EVALUATING BEER COLOR PREDICTIONS FROM RECIPES

By Thomas Kraus-Weyermann and Horst Dornbusch

BEER COLOR VALUES IN COMPARISON.

This is the last part in a three-part series of articles about beer color. Part 1 examined the evolution of color measurements of finished beers [1]. Part 2 outlined the logic behind five popular, malt-based, mathematical color predictors that are commonly used throughout the world at the recipe design stage [2]. Finally, this article looks at three beers brewed specifically for this study to evaluate the saliency and precision of the formulae presented in Part 2 by comparing their predictions to actual laboratory color measurements.

As elaborated in Part 1, the international brewing community now measures beer and wort color by using uniformly accepted analytical methods developed by the American Society of Brewing Chemists (ASBC) and the Mitteleuropäische Brautechnische Analysenkommission (Central European Commission for Brewing Analysis or MEBAK®) [1]. For these measurements, samples need to be taken and processed under standardized conditions, using standardized equipment. The results produced by these methods may not capture the human perception of beer color perfectly, but they are adequately representative of reality to allow for useful and practical comparisons across beers of different colors.

The five formulae presented in Part 2 for the advance calculation of beer color values [2] have no official names. Therefore, this study labels them with the names of the originators of these equations or of the authors who describe them in publications. These are the "Krüger formula," the "Mosher formula," the "Daniels formula," the "Morey formula," and the "Weyermann formula." All of these formulae incorporate, in one way or another, a "malt color unit" (MCU), which is defined as the sum of the proportionate color contributions of each individual malt in the mash to the wort, and thus,

Figure 1: Three test brews, three spectrophotometrically measured color values. From left to right: A Bohemian Pilsner, a Bohemian Amber Lager, and a Bohemian Dark Lager.

TABLE 1: TEST BREW SPECIFICATIONS.

Variable	Batch size: 275 liters. All units in the metric system only.		
	Bohemian Pilsner	Bohemian Amber	Bohemian Dark
Total dry grain weight	46.5 kg	46.5 kg	46.5 kg
OG	11.7°P	11.7°P	12.3°P
FG	2.5°P	2.6°P	2.7°P
ABV	5.1%	4.9%	5.4%
Malt Weights (Color)	Bohemian Floor-Malted Pilsener 42.8 kg (3.75 EBC); Carafoam® 2.3 kg (4.5 EBC); Acidulated malt 0.9 kg (6 EBC); Carabohemian® 0.5 kg (195 EBC)	Bohemian Floor-Malted Pilsener 39.1 kg (3.75 EBC); Carafoam 2.3 kg (4.5 EBC); Acidulated malt 0.9 kg (6 EBC); Caraaroma® 1.9 kg (400 EBC)	Bohemian Floor-Malted Pilsener 39.1 kg (3.75 EBC); Carafoam 2.4 kg (4.5 EBC); Carabohemian 2.4 kg (195 EBC); Acidulated malt 0.9 kg (6 EBC); Carafa® Type III 1.9 kg (1,400 EBC)

ultimately to the finished beer. The MCU also takes into account the amount of wort extracted from the mash. For the following discussions, therefore, it might be helpful to first re-read Part 2 of this series.

Four of the formulae discussed in Part 2 are linear functions, while one, the Morey formula, is logarithmic. The prima facie problem with each of these formulae is the vast difference in outputs they tend to generate from identical inputs. The extent of these discrepancies is already documented in Table 1 of Part 2. This same table also demonstrates that some color formulae are much more predictive than others when their results are compared to laboratory measurements. This third installment seeks to confirm the accuracy (or lack thereof) of these formulae under controlled conditions by creating three test brews with identical specifications for original gravity, final gravity, alcohol content, total dry grist weight, batch size, and yeast (Table 1). This ensures that all brewing variables except for the colors of the three beers remain constant and no extraneous factors (see bulleted list below) could distort the analysis.

THE TEST SETUP

The first step in the empirical test was to create specifications for three beers (see Table 1)—a blond, an amber, and a dark—and then run the grain bills through each of the five color equations. The base malt for all three batches was Bohemian Floor-Malted Pilsner. However, the base malt quantities varied slightly because of the different amounts of specialty malts needed to reach the different beer color targets. The color calculations by the five formulae under investigation for each of these three beers are shown in Table 2.

The next step was to brew these three beers in the same brew house using identical processes. Our test setup was the 2.5-hectoliter brew system of the pilot brewery inside the Weyermann Malting Company in Bamberg, Germany. Once fully fermented, the beers were analyzed for their true color values using standard MEBAK analytical methods and a spectrophotometer (Fig. 1). Note that the spectrophotometer readings shown for the two darker brews reflect the measurements for liquids that have been diluted with distilled water to create proxy values that are within the accuracy range of the spectrophotometer. This is because the device is calibrated to generate reliable results only up to about 60 EBC. For additional explanations of this process, see Part 1 of this article series [1].

Photos courtesy of Weyermann® Malzfabrik, © Getty Images

The final step was to compare the color values predicted for these three beers as shown in Table 2 with the actual color measurements. The discrepancies between the advance calculations and the measurements after the fact are shown in Table 3.

KEEPING "EVERYTHING ELSE EQUAL"

In Table 1 of Part 2 of this article series [2] the five formulae under investigation are applied to 20 very different beers with widely varying colors, alcohol levels, and grain bill compositions. The table already provides strong indications that not all of these formulae are equally trustworthy, but it does not ascribe causalities for the discrepancies. For a more in-depth analysis, therefore, it is necessary to control for any extraneous factors that can influence the beer color calculations and measurements—during the entire beer making process, from the grist mill to the packaging line. Even though none of these factors are as significant for assessing beer color as are the malt colors, they can nonetheless create a certain degree of disorder and randomness. However, because these factors are difficult to quantify and thus next to impossible to enter into a mathematical equation that would be useful for the practical brewer, the "everything-else-equal" rule of the experiment is essential.

The following is a partial list of these potentially distorting forces:

- Already at the very beginning of the brewing process, the mill gap setting, which is responsible for the fineness or coarseness of the grist, can affect the color value of the finished beer. Generally, the coarser the grist, the less color can be extracted from a given mash.
- Not surprisingly, the longer the mash time (and the slower the run-off during lautering), the darker the color of the finished beer.
- In the brew kettle, the non-enzymatic browning effect of the Maillard reaction between sugars and amino acids obviously causes some darkening of the beer. It is generally accepted that an hour of boil time darkens the wort by about 1.5 EBC (approx. 0.75 SRM). By the same logic, decoction mashes tend to produce slightly darker beers than do infusion mashes, assuming all other factors are equal. The same applies to direct-fired as opposed to indirect-fired kettles.
- Air pickup during the brewing process can promote the oxidation of such polyphenols as flavonoids, which are naturally present in grain husks and hops. When flavonoids oxidize, they form brown pigments, which, in turn, can strongly influence not only the beer color but also the beer's astringency and haze.
- The effectiveness of the hot and cold break is another factor that can influence the accuracy of any color predictions or measurements because any imperfect sedimentation of tannin-rich, color-inducing particulate can lead to a cloudier and darker beer.
- Though difficult to quantify, different yeast strains and their different fermentation byproducts can also affect beer color.
- If cereal adjuncts such as corn and rice or unmalted barley and wheat are used in the mash, they can impact the mathematical predictability of any beer color formula. Just like malted barley, these grains have a certain mass, but they affect beer color differently. While rice adjuncts, for instance, have next to no color effect and corn adjuncts, only a slight one, unmalted roasted grains have a severe darkening effect that is disproportionate to their mass.
- Roasted malts (like roasted grains) also affect beer color disproportionally

TABLE 2: BEER COLOR PREDICTIONS FOR THE FINISHED BEERS, BASED ON RECIPE SPECIFICATIONS.

Formula	Units in EBC (SRM)		
	Bohemian Pilsner	Bohemian Amber	Bohemian Dark
Weyermann	10.5 (5.3)	38.3 (19.4)	85.9 (43.6)
Krüger	10.8 (5.5)	34.2 (17.3)	65.7 (33.3)
Mosher	11.2 (5.7)	11.8 (6.0)	31.4 (16.0)
Daniels	17.7 (9.0)	18.1 (9.2)	31.2 (15.8)
Morey	6.2 (3.1)	7.7 (3.8)	35.1 (17.8)
Empirical measurement results	Spectrophotometric Color Measurements		
	10 EBC (5 SRM)	40 EBC (20 SRM)	82 EBC (42 SRM)

TABLE 3: DIFFERENCES BETWEEN COLOR PREDICTIONS BASED ON RECIPE SPECIFICATIONS, ON THE ONE HAND, AND SPECTROPHOTOMETRIC MEASUREMENTS OF ACTUAL COLORS AT TERMINAL GRAVITY, ON THE OTHER (IN EBC UNITS).

Formula	Bohemian Pilsner (10 EBC)	Bohemian Amber (40 EBC)	Bohemian Dark (82 EBC)
Weyermann	+0.5	–1.7	+3.9
Krüger	+0.8	–5.8	–16.3
Mosher	+1.2	–28.2	–50.6
Daniels	+7.7	–21.9	–50.8
Morey	-3.8	–30.3	–46.9

compared to the color values stated by the maltster. A roasted malt of 1200 EBC (approx. 450°L), for instance, has three times the numerical color value of an aromatic malt of, say, 400 EBC (approx. 150°L), but it contributes more than three times the amount of color to the finished beer.

- Next, the pH drop at the start of fermentation plays a role in the color formation of the finished beer because acidic solutions promote the sedimentation of color-causing particulate, while alkaline solutions do not. In general, therefore, as brews darken, darker brews do so much less than paler brews.
- Another complicating factor is inherent in the measurement process itself: The single-wavelength light of 430 nanometers (nm) that is employed by most modern spectrophotometers (see Part 1) provides a reading that can appear different from the color that humans see. This is because the human eye recognizes the reflections and refractions of all wavelengths in the visible spectrum, which stretches for most humans from roughly 400 to 700 nm; that is, from violet to red. In ordinary language, we call this multi-wave light effect a "hue." Because humans can see such hues and a spectrophotometer cannot, they may influence our overall perception of a beer's color.
- Finally, of course, whether a beer is filtered or not matters for the measurement of beer color. Any turbidity (or carbonation, for that matter) in the beer affects the absorbance of light and thus the perception of color. Therefore, filtered beer appears lighter than the same beer from the same mash in its unfiltered stage. This is why beer color measurements according to the ASBC and MEBAK procedures (see Part 1) must be taken with severely filtered beers only, which also eliminates the CO_2 factor for the spectrophotometer.

Given the above influences, which spectrophotometry cannot eliminate, the goal of any formulae for beer color predictions, as well as any measurement technique, can never be made with total precision. Nonetheless, we should be able to expect results to fall within at least a reasonable tolerance interval, whereby different brewers may have different subjective thresholds for the degree of mathematical deviation they will accept. To the extent, therefore, that the above variables can be kept unchanged across several brews, the calculated and measured values become more reliable and, importantly, directly comparable.

PREDICTIONS VS. MEASUREMENT

As Tables 2 and 3 show, the Weyermann, Krüger, and Mosher formulae perform reasonably well for the Bohemian Pilsner

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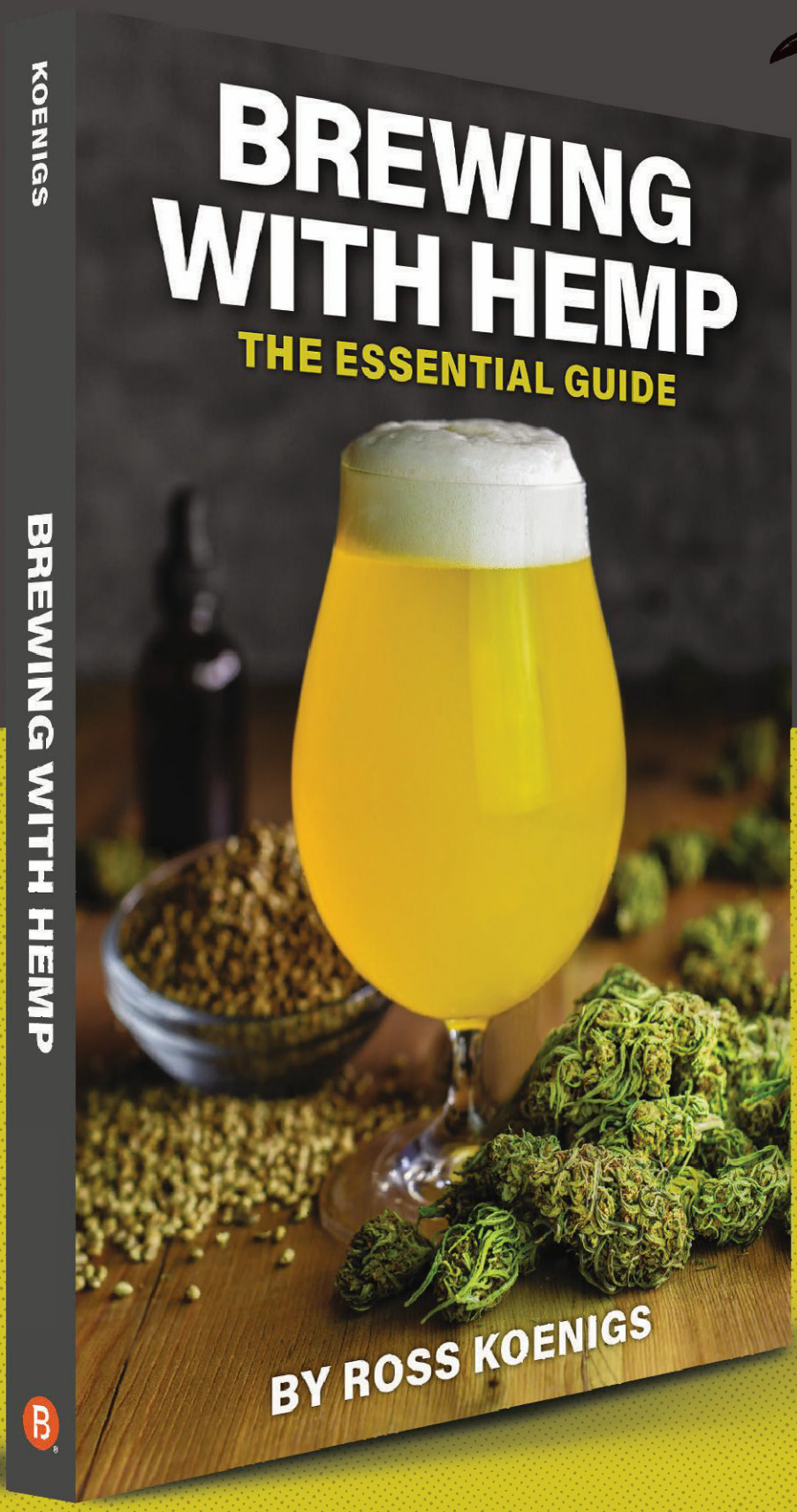

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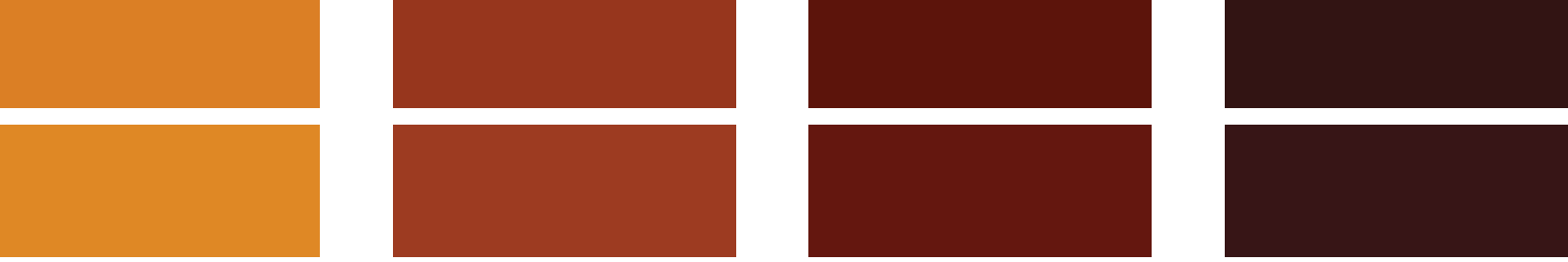

compared to the measured value (of about 10 EBC), while the Daniels value is much too high (dark) and the Morey value, much too low (pale). In the midrange, for the Bohemian Amber (at around 40 EBC), all formulae report smaller (lighter) values than the actual measurements; however, the Weyermann formula is off by only a minuscule amount, which might not even be discernible with the naked eye. The Krüger formula is also off, but only by about 15 percent. The formulae developed by Mosher, Daniels, and Morey, on the other hand, are off significantly.

As a beer becomes much darker, in the vicinity of roughly 80 EBC, the discrepancies between predictions and measurements increase for all formulae. However, the Weyermann formula still generates a value that is only about 4 percent higher (darker) and thus very close to the actual measurement. The Krüger value is about 20 percent smaller (lighter) than the measured value. These discrepancies, however, have only limited practical significance, because a beer color of 80 EBC is close to the threshold beyond which humans can no longer distinguish between various shades of darkness. The same deviations do not apply to the three other predictions, which underreport the actual laboratory-measured color value of the Bohemian Dark by significant amounts, with the logarithmic Morey formula performing only slightly better than the Daniels and the Mosher formulae (Table 3).

CONCLUSION

The test brews made for this analysis clearly demonstrate the strengths and limitations of each formula.

The Krüger formula showed its strength in the lighter color range, but, as the beers got darker it underreported color values progressively, though not catastrophically. The Mosher formula was also fairly accurate for the Pilsner, but underreported color values dramatically for the Amber and the Dark. On balance, the Daniels formula was the least accurate among the four linear equations, producing questionable results for all three color ranges. The logarithmic Morey formula, on the other hand, even though it is very popular with online recipe calculators, performed reasonably well only for the Pilsner, but went completely off the track for the Amber and the Dark. The Morey formula was also the only one that generated smaller (lighter) values for all three beers. Significantly, the Weyermann formula produced color predictions that were consistently close or even very close to the true measurements. The calculated values for the Pilsner and the Dark are only minimally larger (darker) than the spectrophotometric measurements, while the value for the Amber is minimally smaller (lighter).

All five formulae considered in this series of three articles incorporate some version of the so-called malt color unit (MCU), but they differ in the selection multipliers and/or numerical add-ons to the equation. In all formulae, the mathematical elements surrounding the MCU are intended to overcome the calculation and measurement distortions caused by extraneous factors listed above. These corrections are experience-based and not derived from theories. They are also intended to be simple and practical, without getting lost in the fallacy of misplaced concreteness or in the paralysis of analysis. The add-ons selected in the Mosher and Daniels equations are constants (4.7 and 8.4, respectively). In the Krüger and Weyermann equations, by contrast, they are variables, which, in turn, depend on the color value generated by these formulae before the multiplications and add-ons are selected. Finally, Morey chose an entirely different strategy. He did not use add-ons, but instead extrapolated the MCU value to the power of 0.6859, which may make sense in theory, but does not deliver in practice.

Given these differences in approaches to the problem of distortions inherent in all beer color predictions and measurements, the investigations and experiments carried out for this article series clearly show that some formulae currently in use for beer color predictions around the world perform better to even much better than others. It turns out that the values generated by the Weyermann formula—which has evolved for decades as a result of practical experiences in the malting plant, and which has never been published before—comes closest to the spectrophotometer measurements over the widest color range. The Krüger formula, which also uses variable add-ons, comes in second. The Mosher, Daniels, and Morey formulae with their fixed add-ons, however, though seemingly much more user-friendly than the other two formulae, have the least amount of predictive strength and accuracy, especially for darker beers.

The above considerations leave the practical brewer with a few clear conclusions: In light of inevitable distortions, any formula for beer color calculations is merely a guide, not a 100-percent prediction, even though some formulae generate tighter measurement tolerances than do others. Finally, because beer color is the result of a multicollinearity of many factors, some of which are next to impossible to quantify mathematically, brewing, especially creative brewing, is still as much intuitive art and craft as it is hard-nosed science and technology.

ACKNOWLEDGMENT

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SKEPTICAL BREWING 4

This is the fourth in a series of articles called "Skeptical Brewing," a deep dive into commonly held brewing beliefs. In this series, we discuss their origin stories and review the science and research behind them to reach a verdict on their plausibility. We have chosen common brewing superstitions to try to challenge established paradigms and shed light on many supposedly unquestionable truths. We hope this helps foster the habit of questioning handed-down wisdom.

Always be skeptical!

By Matias Cavanna and Leandro Meiners

1 CARBON DIOXIDE (CO_2) IS HEAVIER THAN AIR AND CREATES A PROTECTIVE BLANKET

Blanketing refers to adding an inert gas, commonly carbon dioxide, to create a layer that sits atop beer and protects it from oxygen. This term is often used in beverage industries (wine, soda, brewing, etc.) and has also been adopted by the homebrewing community.

In many countries, pubs with underground cellars or closed spaces where CO_2 is used for draught systems, are required to have a CO_2 monitor to ensure CO_2 levels do not climb too high. Drowsiness commences at concentrations higher than 1 percent, heart rate and blood pressure are affected when the concentration exceeds 3 percent, and unconsciousness can happen at 7 percent.

This seems to support the idea that CO_2 will sink or layer just like oil and water do if put together in the same container, which would create an effective protective "blanket." Beverage industry gas suppliers describe blanketing as replacing air in the headspace with an inert gas, and advertise it as a way to combat oxidation.

It is common to read in brewing forums for both home- and professional brewers that, as CO_2 is denser than air, oxidation can be avoided by adding CO_2

- To a keg prior to filling,
- To a secondary fermenter or bright tank prior to transfer,
- To a mash tun for low-oxygen brewing (LODO),
- Or to a brewing kettle prior to kettle souring.

The first method to force carbonate beverages (water) was discovered by Joseph Priestley in 1772 in a published work in which he explains the method to impregnate water with "fixed air" (as oxygen was referred to in this use).[1] Shortly after that, Jacob Schweppe developed the first industrial process to mass produce carbonated mineral water.

The use of "forced" CO_2 in brewing (i.e. CO_2 "injected" in the process, regardless of the source) started in the late 1800s in the USA. Horace Brown describes in 1897 the use of a "carbonator" similar to the ones used to produce carbonated water.[2] Prior to the introduction of forced carbonation, CO_2 in beer was naturally produced during cask- and bottle-conditioning. Lloyd Hind documented in 1923 that CO_2 is not only used for carbonation, but in →

other brewing processes, such as in racking products from one tank to another, pushing beer through filters, and other uses.[2] We believe that blanketing could not have been used as a brewing practice until the 1920s.

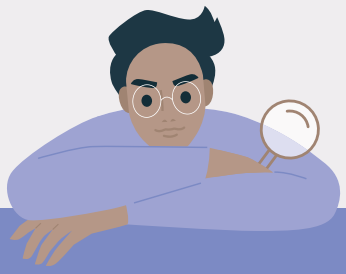
WHAT DOES SCIENCE HAVE TO SAY?

Air is a gas mixture composed mostly of nitrogen (78 percent) and oxygen (21 percent). Argon (0.9 percent), CO_2 (0.03 percent), and other trace gases make up the remaining 0.17 percent. The molecular weights of nitrogen, oxygen, carbon dioxide, and air are 28 grams per mole (g/mol), 32 g/mol, 44 g/mol, and 29 g/mol, respectively. While it is clearly true that CO_2 is denser than air, it is also true that CO_2 is a constituent of air. Carbon dioxide and air don't naturally stratify. If they did, we would struggle to breathe at sea level.

Gases are predictable, and physical laws allow us to understand how they behave. They are all miscible with one other, meaning they form a homogeneous solution, at atmospheric pressure. The gas laws that apply in this matter, Fick's laws of diffusion, were published in 1855.

Fick's first law states that a fluid, in this case a gas, will move from a region of high concentration to a region of low concentration across a concentration gradient, depending on the temperature, viscosity and size of the particles. Fick's second law predicts how diffusion changes with time: basically the longer you wait, the more homogeneous a gas mixture becomes.

Diffusion is the spreading and mixing of a gases as a result of the random movement of its molecules. Given enough time, stratified (layered) gases will mix and distribute uniformly to occupy the space they are in, even in the absence of turbulence, due to this "random" (Brownmian) motion of its particles. →



TEST IT YOURSELF!

Still skeptical and unwilling to let all this scientific research change your mind? Make this experimental brew and challenge your and your mates' taste buds!

DOMO ARIGATO

HOPPY JAPANESE RICE LAGER

This modern take on a Japanese rice lager is dry and refreshing. The tropical, citrusy flavor will allow you to test the effect of whirlpool hopping temperature on the "juiciness" of the finished beer.

You can brew two beers separately from scratch or boil one wort and divide it into two batches at knockout to try two whirlpool addition temperatures, one at 90°C (194°F) and the other at 70°C (158°F). Or, just choose either of the two whirlpool temperatures, brew, and enjoy!

Batch volume: 19 L (5 US gal.)
Original gravity: 1.046 (11.4°P)
Final gravity: 1.008 (2.1°P)
Color: 3 SRM
Bitterness: medium-low
Alcohol: 5% by volume

MALTS

2.5 kg (5.5 lb.) German Pilsner malt
1.7 kg (3.75 lb.) flaked rice

HOPS

10 g (0.35 oz.) Sorachi Ace, 11.5% a.a. @ 60 min
10 g (0.35 oz.) Sorachi Ace, whirlpool at 90°C (194°F) *or* 70°C (158°F)
10 g (0.35 oz.) Vic Secret, whirlpool at 90°C (194°F) *or* 70°C (158°F)
20 g (0.7 oz.) Sorachi Ace, dry hop when SG < 1.015
20 g (0.7 oz.) Vic Secret, dry hop when SG < 1.015

YEAST

Fermentis W-34/70, Lallemand Diamond Lager, White Labs WLP830 German Lager Yeast, Wyeast 2206 Bavarian Lager Yeast, Omega Yeast OYL-102 American Pilsner, Omega Yeast OYL-113 Mexican Lager, or any other crisp lager yeast

WATER

Ca 50 ppm, Mg < 10 ppm, Na < 10 ppm, SO_4 60 ppm, Cl 40 ppm, HCO_3 < 10 ppm

ADDITIONAL INGREDIENTS

0.5 tablet Whirlfloc @ 10 min1 tsp.
(3 g) yeast nutrient @ 5 min (double the normal amount)
110 g corn sugar (if bottle conditioning) to 2.4 vol. (4.8 g/L) CO_2

BREWING NOTES

Mash 70 minutes at 64°C (147°F) and a mash pH of 5.2–5.5. If sparging, do so at 75–78°C (167–172°F). Collect enough wort in the kettle to yield 5 gal. (19 L) into the fermenter.

Boil wort vigorously for 60 minutes, adding Whirlfloc, yeast nutrient, and kettle hops as per the required schedule. After the 60-minute boil, lower the temperature to either 90°C (194°F) or 70°C (158°F), add whirlpool hops, and steep 10 minutes before chilling the wort.

Chill wort to 10°C (50°F) and transfer to fermenter. Aerate thoroughly and pitch yeast. Start fermentation at 10°C (50°F) and increase temperature by 1°C (1.8°F) each day. Add dry hops as per the indicated schedule.

After 3 days with no yeast activity (no gravity change), cold crash and chill the beer to as close to 0°C (32°F) as you can. Keep chilled for a week or two prior to bottling or kegging with 2.4 vol. (4.8 g/L) CO2.

VERDICT

The key to effective blanketing comes from creating non-equilibrium conditions to produce blankets that are continuously replaced. This can be achieved by gently and constantly flowing CO_2 (a slow flow is needed to avoid excessive turbulence), which, due to the temperature and concentration, will form a temporary layer.

Such gentle, continuous CO_2 injection is impractical and expensive at the homebrew scale. The way homebrewers usually think of "blanketing" doesn't actually deliver the desired benefits.

- If you are trying to create a blanket on top of your brew kettle for a kettle sour, the CO_2 layer will quickly diffuse after you stop injecting CO_2, regardless of how good or fast you are at wrapping the kettle lid with film.
- If you open ferment or simply cover your fermentation vessel with aluminum foil, the CO_2 layer will be gone shortly after active fermentation has completed.
- While it is true that a *hermetically closed fermenter headspace* will probably be mostly CO_2, as soon as that fermenter lid is open (e.g. for a dry hop or for kegging), the CO_2 will quickly diffuse with the air around and not remain layered on top of the liquid.
- If you open-fill your kegs, the CO_2 with which you purge the keg will mix with air as you fill them.

The most effective way to purge a pressure-capable and hermetic vessel (keg, secondary fermenter, bright tank, or even transfer hoses) to ensure nothing but CO_2 remains prior to filling with beer is to first fill with a liquid (ideally a non-oxidative sanitizing solution) and push it all out with CO_2. This leaves behind a sanitized vessel filled with carbon dioxide.

Considering that "blanketing" is normally considered a protective, semi-permanent CO_2 layer that forms by releasing some gas on top of a non-hermetically closed and non-pressure-resistant vessel, such as a plastic bucket fermenter or a brewing kettle, we can call this claim an **outright myth**.

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2
FILTRATION REDUCES HOP AROMA AND FLAVOR

The origin story in this case is really about different brewing schools of thought. Ask a brewer how they feel about filtration and the answer will likely reflect how they were trained. The "clarity is king" mindset typical of German or macro-brewing approaches will usually endorse filtration. Brewers from American-craft and English schools of thought, however, may insist that filtering strips away flavor and removes yeast needed for proper conditioning.

Regardless, what we want to discuss is how much scientific merit is behind each school of thought.

WHAT DOES SCIENCE HAVE TO SAY?

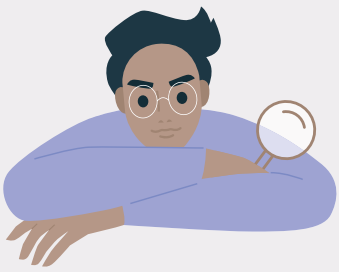
The sad reality is that we don't know a whole lot on the topic. Judging from the reactions it elicits in brewers and its possible impact on quality, one would expect this question to be of academic interest. However, the lack of studies does not support this reasoning, perhaps because the large breweries that fund much of the academic research have already taken a stand on the issue. Or, it could be, simply, that each school does not want to challenge its stance.

We focus here on the effect of filtration of dry-hopped beers, but most of the conclusions can be applied to hop aroma compounds coming from kettle hopping, whirlpool hopping, and fermenter hopping as well. A deep dive into the academic literature has only turned up one paper that tackles the subject head-on and two others that consider it tangentially.

In "On Hops, Filters and Precious Oils," the only article we found whose main focus is understanding the effect of filtration on dry-hopped beers, the results of filtration are considered for the following four aromatic compounds:[1]

- **Myrcene**, the most abundant terpene in hops, is highly volatile and typically described as having pine-like, herbal, and even citrus character.
- **Ethyl hexanoate**, a fruity ester reminiscent of pineapple, delivers tropical notes in low concentrations.
- **Linalool**, the standard in the scientific literature for "measuring" as a marker for hop aroma intensity, is often described as being floral or citrus, with lavender notes.[2]
- **α-terpineol** expresses floral (lilac) and citrus character. Thanks to its high perception threshold, α-terpineol isn't necessarily the most direct marker for "hoppy," but it could still contribute to the overall hoppy intensity.[3]

Given the components analyzed, the authors evidently sought to select representative components for "hoppy" aroma that covered all major aroma compound families: monoterpenes, esters, and terpene alcohols. Nevertheless, bear in mind that it is still a fairly small subgroup; it would be interesting to see the study reproduced with at least 10 to 15 compounds that affect hop aroma. →



FILTERING STRIPS COMPOUNDS, AMONGST THESE, AROMA COMPOUNDS.

The study examines how filtering with two different pads, one made of cellulose and the other made of diatomaceous earth, affects these compounds. In the case of the cellulose pad, the concentration of all compounds except myrcene decreased by 15 to 30 percent at the beginning of filtration. After the first few liters of filtrate, the concentrations slowly recovered and stabilized to near those of the unfiltered sample, about 5 to 10 percent lower. On the other hand, myrcene showed a very marked initial drop of more than 55 percent, which then only recovered by 5 to 10 percent.

The trend with the diatomaceous earth filter is similar, but all the effects are more pronounced: the initial drop is larger, recovery is slower, and the final values at which the concentrations settle are lower. Obviously, this leads to a more marked impact on aroma. Sadly, the study only examines the first 45 liters of filtrate, without clarifying whether or not it corresponds to the total, and therefore it is difficult to know how the trend might stabilize with a larger filtered volume.

The authors argue that the difference is given by the adsorption of the filter material, i.e., when compounds adhere to the filtration surface (not to be confused with absorption which is when molecules are "soaked up" into the filtration medium). The weaker it is, the faster the saturation point is reached and, therefore, the stabilization phase will begin earlier, leading to compound levels closer to the original values, with a consequent lower loss of aroma.

In addition, they assert that the results show that the losses are mainly influenced by the molecular properties of the different compounds: their size and polarity. For example, the hydrophobic character of myrcene can explain its higher loss.

In "Headspace Trap GC-MS Analysis of Hop Aroma Compounds in Beer," the effect of dry hopping with Lemondrop hops (static cold dry hopping with 7 days of contact and a rate of 25 g/L) in a Pilsner and a pale beer is compared, where only the lager was filtered.[4]

The results presented by the authors show that the terpenes myrcene, β-caryophyllene, α-humulene, β-farnesene, and β-limonene are found in lower concentration in the Pilsner than in the pale ale. The authors postulate that it may be due to filtering, which would be compatible with the other studies discussed in this article. Since these are two different beers, though, it could be due to other factors that modify the amount extracted from the hops and/or any biotransformation from yeast.

In agreement with the other studies cited, the authors found no significant differences with the more polar compounds: linalool, geraniol, and α-terpineol. However, the esters are completely differ-

ent, although this could be due to the use of different strains in fermentation, which would not give us information on the effect of filtering.

The studies back up our intuition: filtering strips compounds, amongst these, aroma compounds. However, assessing the impact of the reduction in terms of the resulting aroma is tricky as the effect is related to the aroma threshold of each compound, the original quantity, and whether the reduction is actually perceivable. For example, a 10 percent loss of a compound that was already present at 10 times its aroma threshold might not have the same effect as a compound that was in low quantities barely above its aroma threshold.

Regardless, on first thought one could argue the reasoning for favoring filtration would be given from an operational point of view (quicker production times); from the style, tradition, or school; for shelf stability (removing yeast); or for aesthetic (beer clarity), but it seems that there could be organoleptic reasons as well.

4MMP, a thiol described as having blackcurrant aroma, influences the aromatic profile of certain hops and, like other thiols, has a significant organoleptic impact even at low concentrations. Its extremely low perception threshold is measured in parts per billion instead of per million.

The authors of "On the Behavior of the Important Hop Odorant 4-Mercapto-4-methylpentan-2-one (4MMP) during Dry Hopping and during Storage of Dry Hopped Beer" analyze the behavior of 4MMP during the dry-hop process. To do this, they carry out a cold static dry hop on a light Pilsner beer, at a rate of 25 grams per liter. They analyze the behavior both from a sensory and analytical perspective on unfiltered and diatomaceous-earth-filtered samples taken after 0, 1, 2, 4, and 8 days of dry hop contact.[5]

Sensory analysis shows a considerable increase in 4MMP during the first two days of contact, after which the change is marginal. Furthermore, the sensory difference between the filtered and unfiltered samples is insignificant. The analytical analysis supports the sensory results (considerable increase during the first two days and negligible thereafter), but exhibits a more marked difference between the filtered and unfiltered samples of just over 10 percent in terms of the transfer rate of the compound into the beer (a measure of how efficient the extraction was). The authors, surprised by the result, repeated the process, obtained the same results, and hypothesized that it may be due to a release of 4MMP from a precursor during the filtering stage.

It is important to note that none of the previous studies analyze the behavior of thiols. Therefore, the result isn't incongruous with the rest; it would be interesting to see if the same result is true for other thiols.

In the specific case of hazy IPAs, which are not commonly filtered are but commonly centrifuged, the negative impact on aroma could be more pronounced. One study, which analyzes the composition of New England IPA, shows that turbidity fulfills the function of retaining greater proportions of certain aromatic compounds, especially the more polar nature, such as myrcene.[6] The aroma impact of these trapped compounds is unclear, and it is not evident that their presence "makes" the style from an aromatic point of view. Nevertheless, filtering presumably could have an even more pronounced negative impact on styling, beyond removing the expected turbidity.

VERDICT

From the studies, it is difficult to conclude that the last word has been said, although they show that filtering does have an impact, hence **the assertion is not a myth**, but it is non-trivial to quantify

the reduction in terms of perception and is **misleading**. Rather than causing a real loss of aromatic quality or intensity, what is truly happening is a modification of the aroma profile by removing a significant portion of certain compounds (highly volatile terpenes, for example) and not significantly altering the concentration of others (linalool, for example). Additionally, it is wise to remember that the impact of filtering strongly depends on the type of filter medium used.

It is clear that filtration changes beer, and our current scientific understanding seems to indicate that the decision is more about reflecting what a brewer hopes to achieve from the dry hop instead of a clear-cut reduction of aroma as a trade-off for clarity. The results suggest that there may even be certain parallels between the results obtained from whirlpool hopping versus dry hopping, where the most volatile compounds are also lost in greater proportion.

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3 LOW-TEMPERATURE WHIRLPOOL OR HOP-STAND ADDITIONS PRODUCE FRUITIER OR JUICIER FLAVORS

Love them or hate them, New England IPAs (NEIPAs) have without doubt challenged and changed many brewing paradigms and brought alternative (some defunct, some new) hopping techniques to light.

It all started in the mid 1990s at the Vermont Pub & Brewery, where Greg Noonan and John Kimmich started focusing on extracting more hop flavor without the added bitterness, not minding the haze. Kimmich opened The Alchemist brewpub in 2003 and kept exploring the path to make a beer that smelled and tasted like great cannabis. It was in 2011 when he started canning the beer that the style snowballed until it became the "next big thing" for craft beer.

Brewers started (and still are) experimenting with different hop addition timings, temperatures, dosages, procedures, and more to extract as much "juiciness" as possible from hops without adding bitterness. Whirlpool and hop-stand additions grew substantially with this trend, and brewers started reducing wort temperature prior to adding post-boil hops to reduce bitterness.

This temperature reduction also helps preserve hop oils, especially highly volatile ones with lower flash points. Thus, many brewers assume and claim that low-temperature hop-stand additions will produce juicier, fruitier flavors. But is it true?

WHAT DOES SCIENCE HAVE TO SAY?

It is true that many hop oil compounds, specifically the hydrocarbon fraction, have lower vaporization temperatures than the other polar fractions. These compounds comprise on average between 40 and 80 percent of the total hop oil (actual values are different for every variety and crop). The most significant compounds in this category are myrcene, humulene, caryophyllene, and farnesene.[1]

This means that lower whirlpool or hop-stand temperatures will undoubtedly help preserve more of the hydrocarbon hop oil compounds. However, it is interesting that these compounds are not generally related to fruity aromatics, but mainly impart green, herbal, piney, spicy, or woody characteristics.

During 2012's World Brewing Congress, Takako Inui from Suntory Beer in Japan, presented his research on this topic.[2] The experiment he conducted started from the same wort and, at the end of boil, divided it into three portions, cooled each to a different temperature—95°C, 85°C, and 75°C—and made an identical whirlpool hop addition to each wort.

The results indicate that the beer that extracted the most linalool (he focused on this compound only for this test) was the one with the intermediate temperature (85°C) whirlpool addition, followed by the low whirlpool temperature (75°C). The lowest linalool content was found in the beer with the highest temperature (95°C) addition.

However, the most interesting results from this experiment come from the tasting panel, which found the high-temperature addition to be the fruitiest and most citrusy of the three beers, The intermediate-temperature addition delivered →

herbal, floral, and woody aromas, and the low-temperature addition was the least aromatic beer of the three, with a higher wood-type aroma balance.

VERDICT

While it is true that low-temperature whirlpool additions volatilize fewer hop oil components than warmer additions, it is interesting to note that:

- Not necessarily will these hop oil components bring juicier, fruitier characteristics. The opposite may be the case, although this is likely hop dependent and hasn't been studied in detail in the literature.
- We will not necessarily end up with more hop oil components by lowering the temperature, as the solubility of some of these compounds might be lower at lower temperatures (such is the case of the lower linalool content for the 75°C addition compared to the 85°C addition in Inui's experiment).
- There are examples (Inui's experience) of lower-temperature hop additions producing less-fruity beer with more herbal and wood-type flavors.

This means we can call this claim an **outright myth**.

This doesn't mean that lowering the whirlpool temperature prior to addition is a bad practice, and that for some hop varieties or beer types low temperatures additions can't produce fruitier, juicier beers. The most important takeaway is that we can't assume it will *always* be the case.

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KAVA

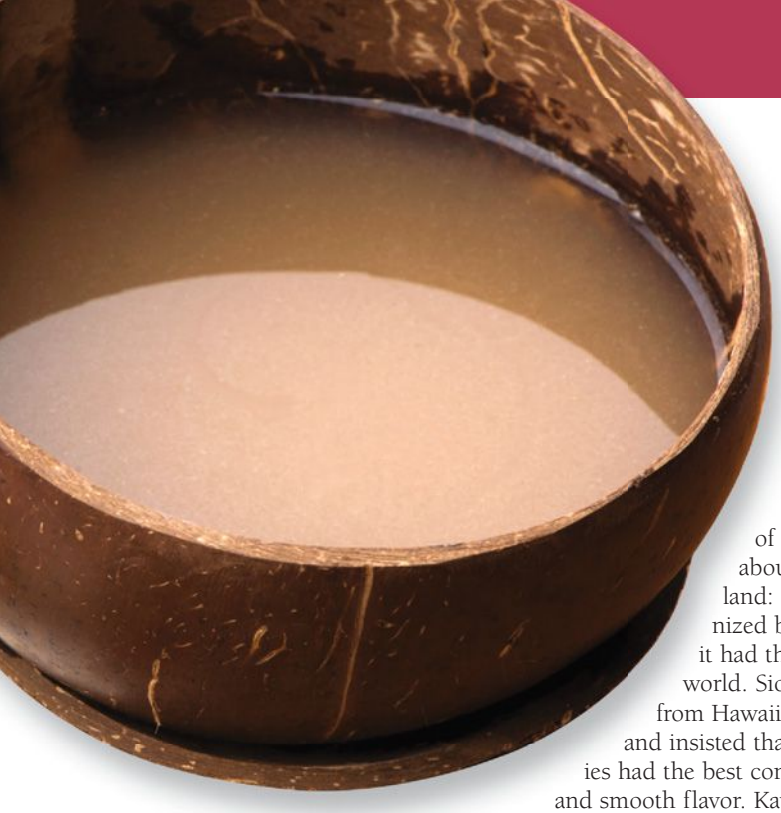
THE CALMING PACIFIC ELIXIR

By David J. Schmidt

Editor's note: *This article is intended to engage readers' curiosity about the world's rich beverage traditions. The American Homebrewers Association and Zymurgy neither encourage nor discourage consumption of kava and kava-containing products.*

I stood in the traditional Tongan thatched hut, known as a *fale* and chatted with my new friend, Sione. On a raised platform before us stood the wide, hand-carved wooden bowl, crafted for one of the most important parts of Tongan life: the beverage known as *kava*.

"There's no better way to spend time with friends and family than by drinking kava," Sione said. He wore an ornately woven *tupenu*, the traditional wrapped sarong skirt of Tonga. "You sit around enjoying each other's company and 'talk story' together. It's the nicest thing in the world." →



The *fale* was perfectly designed for this tropical weather. A refreshing island breeze blew in through the open doorway as Sione explained the cultural significance of kava: a sacred tradition, a rite of passage, the drink of royalty, and the sacramental link to ancestral spirits. "I'm glad the young generations are keeping the tradition alive," he said. "It's important to…"

Our conversation was interrupted by a knock on the doorway of the hut.

"Excuse me." A sunburned Midwestern man wearing Oakley sunglasses peered in. "Did I miss the four o'clock dance performance?"

Sione checked his Apple Watch. "No, you've got time. It'll be in Amphitheater B, just past the snack cart."

Okay, we weren't actually in Tonga at the time. Instead, the traditional *fale* hut was located in the Polynesian Cultural Center, a theme park in Hawaii.

Still, everything Sione told me about kava was true. This relaxing, euphoric, ancient brew has been a part of Polynesian traditions for millennia, in places like Tonga, Hawaii, and far beyond. In recent years, it has seduced the rest of the world as well.

THE ANCIENT ISLAND BREW

Kava is a drink cold-brewed from the root of the *Piper methysticum* plant. The root is either pounded, ground, or grated into a powder, then mixed with cold water and strained. It is brewed throughout Oceania, on islands separated by thousands of miles of ocean: Fiji, Samoa, the Marquesas Islands, Tahiti, Vanuatu, Papua New Guinea, Irian Jaya, and the islands of Micronesia. And of course, in Hawaii, where I met Sione last November.

He told me two of the proudest facts about his Tongan homeland: it was never colonized by foreigners, and it had the best kava in the world. Sione had tried kava from Hawaii, Fiji, and Vanuatu, and insisted that the Tongan varieties had the best combination of potency and smooth flavor. Kava from Fiji, by contrast, was stronger and much more bitter.

Of course, bitterness is unavoidable when it comes to kava. Nobody drinks it for its flavor, which could most generously be described as "barely palatable dirt." In fact, the native Hawaiian word for it, *ʻawa* (pronounced "ava"), also translates as "sour" or "bitter." The expression *ʻAwa ka ʻupena*, means "the net is sour," referring to when fish refuse to enter a net. In many languages around the world, in fact, brewing and fermentation terms are related to the word for "sour."

A more significant connection to other traditional brews is found in the cultural role of kava. It is linked to sacred rites, is described in mythological terms, and foments bonding and social cohesion. It reminds me of many other folk brews I've covered in this magazine: Amazonian chicha; Mexico's pulque and tesgüino; Ethiopian t'ej mead.

There is one key difference, though—kava contains no alcohol.

The soothing and euphoric effects of kava are achieved by a different chemical entirely: the natural kavalactones contained in the *Piper methysticum* plant. Its effect on drinkers is unlike any other brew on earth.

The first time I tried kava, it brought to mind the most pleasant effects of my favorite drugs: that first cup of hot coffee in the morning, that first cold beer after a hard day's work, the calming, optimistic sense that "everything is going to be all right."

And yet, kava didn't seem to include any of the bad parts of coffee or beer. I was alert and awake, but without the jitters of caffeine. I was calm and relaxed, but without the sluggish impairment of alcohol. The closest thing I could compare it to was the South American tea brewed from fresh coca leaves. If that's not a familiar reference for you, just imagine the endorphins of a nice runner's high.

The researcher A.M. Hocart wrote in 1929 that kava "gives a pleasant, warm and cheerful, but lazy feeling, sociable, though not hilarious or loquacious; the reason is not obscured." The authors of the book *Kava: The Pacific Elixir* explain that a kava drinker "attains a state of happy unconcern, well-being and contentment, free of physical or psychological excitement. At the beginning conversation comes in a gentle, easy flow and hearing and sight are honed, becoming able to perceive subtle shades of sound and vision. Kava soothes temperaments."

In an article for the *San Francisco Gate,* meanwhile, David Thompson wrote that "it makes your worries seem manageable, your bones seem to settle into place, and your brain feels focused, friendly and clear. It's as if you've just done 90 minutes of intense vinyasa flow yoga, without the sweat-soaked laundry. And it relieves toothaches."

It's no wonder that kava came to occupy such an important place for the people who live in its natural habitat: the thousands of islands scattered across the vast expanse of the Pacific Ocean.

SUSTENANCE OF THE GODS

I couldn't help but feel a sense of hushed reverence when I first set foot in Honolulu's Bishop Museum. The soft lighting created an air of reverence, fitting for the sanctuary of relics representing millennia of human traditions. It felt almost like a secular temple, similar to the rich historical museums of Mexico City and Ethiopia. Enormous dual canoes hung suspended from the ceiling; a thatched wooden *hale* house stood adjacent to imposing carved statues of Kū, the god of war.

Perhaps the most unique aspect of the Bishop Museum is how geographically vast its subject matter is. Polynesia is spread out over thousands of miles of open ocean, all the way from Hawaii in the north to New Zealand, 4,600 miles to the south, to Rapa Nui (Easter Island), just as far away in the east.

Despite these extensive distances between the islands, the cultures of Polynesia are remarkably similar. These people fearlessly navigated the waves of

the Pacific, migrating, trading, and settling tiny specks of land amid endless expanses of water. They have more in common with each other—in their material culture, ritual life, mythologies, and even languages—than neighboring nations in most parts of the world. Notably, when my friend Sione moved to Hawaii from Tonga, over three thousand miles away, he immediately felt right at home.

One of the most notable commonalities is kava. It is consumed all over the Pacific, across the regions of Polynesia, Melanesia, and Micronesia, and appears over and over in the Bishop Museum's exhibits.

In ancient Hawaii, 'awa (kava) was associated with the primordial god Kāne, the life-giver and one of the oldest deities. Kāne was the creator god, the light of the first dawn, guardian of fertility, agriculture, fishponds, and freshwater. He was present in many sources of life and fertility: the fresh water springing from the earth, men's sperm, and—notably—in "the mixing of *'awa*, the most desired of sustenance by the gods."

The 'awa plant was brought to Hawaii by the gods Kāne and Kanaloa from the mythical ancestral homeland of *Kahiki*. The most sacred ceremonies and holidays in the Hawaiian tradition involved 'awa. The *kahuna* priest would pour the drink onto the shrine and then drink some himself, sharing in the sacrament with the gods. Over time, it moved beyond the priestly class to become a drink for commoners as well, who drank it to pray for prosperity and a good harvest.

Mark Twain learned of it when he visited the Kingdom of Hawaii islands in 1866. He wrote, "around a small shanty was collected a crowd of natives buying the *awa* root." In addition to its popularity, many locals described its medicinal properties. "It is said that, but for the use of this root, the destruction of the people in former times by certain imported diseases would have been far greater than it was…"

Kava was sacred to many other Polynesian nations as well, who drank it as they prayed to the gods and ancestors for health, wisdom, and guidance. In Samoa, the younger daughters of the high chief, known as *taupou,* prepare it for the chiefs while wearing ornate headdresses. This ceremony is central to the gathering of different chiefs and the welcoming of visitors. The high chief presides over the ceremony, determining where kava-drinking guests will sit according to their rank and prestige.

Kava is a mildly narcotic drink made from mixing the powdered root of the pepper plant with water.

Traditional kava bowls from across Polynesia, on display at the Polynesian Cultural Center.

The root of the pepper plant—piper methysticum—is used to produce the Kava drink.

Chris Kilham researched the brew extensively for his excellent and thorough book, *Kava: Medicine Hunting in Paradise*. He suggests that the transcendental experience of Polynesian rituals may be rooted in much more than mere blind faith. "If one seriously considers Carl Jung's assertion that there is a collective unconscious [...] then the notion of gaining entree to ancestral wisdom via kava consumption is completely plausible."

FROM PROHIBITION TO CELEBRATION

Kilham's book describes the fate of kava after foreigners arrived. Because of kava's links to native spirituality, Protestant missionaries condemned it when they first came to the South Pacific.

William Ellis, a missionary to the Society Islands in the early 1800s, wrote that "under the unrestrained influence of their intoxicating draught, in their appearance and actions, they resembled demons more than human beings." William Gunn, a missionary on the island of Futuna, wrote that kava drinking was "a heathen custom, and contrary to Christianity." He described kava drinkers as "bleary-eyed, staggeringly, helplessly, disgustingly *drunk*." (This, despite the complete absence of alcohol.)

In addition to religious opposition, foreigners were horrified by the traditional method of preparation: natives would chew the root and spit it out.

The first written account of kava comes from Captain James Cook's voyages across the South Pacific. A botanist on board his second voyage, Johann Georg Forster, wrote in 1773 that it was "made in the most disgusting manner that can be imagined [...] the root is cut small, and the pieces chewed by several people, who spit the macerated mess into a bowl [...] They swallow this nauseous stuff as fast as possible…"

Although Europeans were repulsed by this unhygienic technique (this, coming from people who only bathed once a month), they failed to recognize it as a form of indigenous science. Through centuries of trial and error, native people realized that enzymes in the human mouth processed the starches in kava root, rendering it more potent. This is similar to the process of making *chicha* from manioc root in the Amazon as well. (See my article "Would You Drink My Spit?" in the May/June 2021 issue of *Zymurgy*.)

As foreigners increased their influence over the region, they launched a full assault on kava. Church leaders managed to eradicate it in many nations, including Tahiti and Kosrae. A key stronghold was in the archipelago of Vanuatu, then known as the New Hebrides. Missionaries to Vanuatu fought the drink for many years; on the island of Aneityum in particular, they managed to destroy every single kava plant.

NOWHERE WAS KAVA MORE STRONGLY ROOTED THAN IN VANUATU.

This was the unfortunate case of Hawaii as well. By the early 20th century, 'awa was entirely prohibited, except with a doctor's prescription. Over the following decades, the ancient drink slowly faded away, relegated to museums and history books.

Thankfully, though, that's not the end of the story.

KAVA MAKES A COMEBACK

Despite the missionaries' aggressive assault on kava drinking across Oceania, the practice lived on. Nowhere was it more strongly rooted than in Vanuatu, legendary birthplace of the plant. When author Chris Kilham traveled there in the 1990s, he found expansive kava farms across the nation's 82 islands, as well as a widespread kava-drinking culture. Men gathered every evening at *nakamals*—simple native kava bars—to drink and "talk story."

A friend of mine from San Diego, Paul Lang, experienced the nakamal culture when he visited Vanuatu in 2010, on assignment for *The Kiteboarder* magazine. The standard serving unit is half a coconut shell. The locals offered him snacks of sweet potato and banana to accompany the bitter drink and encouraged him to sit quietly in the dark shack and "listen to your kava." He found the effects mellow and calming and didn't realize how long they lasted. At dinner hours later, his friends told him he "was talking much more slowly than normal."

In other nations across the South Pacific, kava culture is also alive and well. Heads of state, including President Lyndon Johnson and Queen Elizabeth, have been honored with a shell of kava during their visits. Even Pope John Paul II drank it while visiting Fiji in 1986. In Hawaii, meanwhile, where it fell into near oblivion for decades, the ancient brew has been making a strong comeback.

Commercial kava bars have popped up all over Hawaii, on practically every island except Ni'ihau, "the forbidden island." There are at least four on the Big Island alone. David Thompson describes several kava bars in his *San Francisco Gate* article. Bayfront Coffee, Kava and Tea serves its shells up ice-cold and offers "ali'i style"—named for the Hawaiian nobility—which is prepared with fresh coconut water instead of water. Kanaka Kava offers *pupus,* appetizers such as kalua pork, sweet potatoes, and poi, to offset the drink's earthy flavor.

When I chatted with Sione at the Polynesian Cultural Center, he told me it was far more than just a commercial product in contemporary Hawaii.

"When you drive up and down the highway here [on Oahu], you can always spot a place where people are drinking kava. You'll see a group of cars and trucks parked off in the woods or in a field, maybe a bonfire or two. That's where the young guys sit around in a circle, drinking kava and 'talking story.'"

He proudly told me that, although many Hawaiian farmers now grow kava, the best product is shipped in from his native Tonga.

"The young people really like it. It's a good thing, because they're not out there getting drunk or getting into trouble. They sit around, chill, and share a shell of kava instead. It's healthy."

As a visitor to the islands, I would not have felt comfortable trying to crash any of these intimate gatherings. Thankfully, kava has spread far beyond its native Polynesia, and I was able to enjoy it in my hometown of San Diego, California.

CALIFORNIA'S KAVA SCENE

San Diego's hip neighborhood of North Park has long been on the cutting edge of cultural trends, home to gastropubs, foodie

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spots, and microbreweries. Appropriately, you can find kava there as well. On a quiet Monday night, I stopped by "Gather Kava Bar" to check it out.

The place had a slick, modern look, with a shiny metallic bar illuminated by low, soft lighting. A languid song by Amy Winehouse hung in the air, and a dozen customers sat quietly drinking in groups. I surveyed the menu. In addition to three types of natural kava, they offered a list of kava cocktails with such whimsical names as "Hot Mess," "Sparkle Pony," and "More Cowbell."

A young man in his thirties appeared behind the bar and introduced himself as Derek. He offered me a kava shot on the house and poured one for himself. We toasted with "*bula*," the traditional Fijian wish for good health.

I felt the effects immediately. A numbing sensation filled my mouth and lips, similar to Novocain, followed by an overwhelming sense of camaraderie and goodwill toward everyone around me. When someone played a noisy game on their cell phone, the kava even managed to suppress my natural impulse to judge him. *Don't worry, David. Some people just like to stay glued to their phones. Not your problem. It's going to be all right.*

This was very different from an alcohol buzz. True to Kilham's description, the calm and euphoria came without the grogginess.

I ordered a flight of natural and infused kavas and took a closer look at the other customers. The crowd ranged between 20 and 40 years old. They looked more "hippie" than "hipster," the sort of chill stoners you'd be more likely to spot in Ocean Beach than North Park. One group of college-age kids caught me eying the carton of grapefruit juice they had brought in. "It enhances the effect of the kava," a shaggy-haired boy told me with a beatific smile. He chuckled. "Cuts the bitter flavor, too."

By my third drink, I noticed the music more acutely. The playlist included an eclectic mix of genres and time periods—motown, R and B, jazz, top 20—all united by the same chill, mellow vibe, reminiscent of the soundtrack from *Jackie Brown*. I could hear each instrument clearly, the sharp wail of the horns, the staccato of the percussion.

I asked Derek about the difference between the varietals of kava. I had read in Kilham's book that over 2,000 types of the plant existed, with 15 native to Hawaii alone. Derek explained that the effects could vary widely from one varietal to another. Some produced a calming mellow, while others energized drinkers. The flavor palate could vary as well. One Hawaiian varietal, known as *papa'ele'ele*, was known for its strong peppery taste, as were many from the Solomon Islands. The older a plant was, the more potent its concentration of kavalactones.

Gather Kava Bar offered three flavors of one varietal, known as Chemotype 243, an import from Micronesia. Derek described it as "more of a full-body feel." San Diego's other kava bar, Kava Collective, sold Fijian kava, known for its energizing effect and head-centric buzz.

By my fourth drink, my body felt pleasantly heavy. I told Derek. "That's just the beginning," he said. He explained that kava often produced a sort of "reverse tolerance," with effects increasing the more frequently you drank it.

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I moved on to one of the mixed cocktails, named "Who Dealt?" which contained coconut cream, ice, and kava infused with pineapple, vanilla, and coconut. I'm not a big fan of sweet drinks, and I usually get sick of the overpowering, saccharine taste about halfway through. Miraculously, this beverage had the opposite effect: the more I drank, the more delicious it became. Each sip contained fresh nuances, as if I were tasting it for the very first time. Derek told me that the coconut cream seemed to enhance the effect of the kavalactones.

By the fifth drink, my hearing had become even more acute. I could clearly make out the conversations of other customers across the room, as if I had those magical "extendable ears" from the Harry Potter books. Soon enough, the other customers wandered over to my end of the bar and introduced themselves. Somehow, as if by telepathy, the topic of Harry Potter came up. They were fans, too. We talked at length about the series—and about kava, and about life—until long after the bar's last call.

I suddenly noticed that my face was sore. I'd been involuntarily smiling for much longer than usual. I gave Derek and the other customers a hug, said goodbye, and each of us drove home with a calm mind and a clear head. I slept soundly and woke up refreshed and alert the next day.

COAST-TO-COAST KAVA

Over the last couple decades, the kava scene has slowly expanded across San Diego, Orange County, Los Angeles, San Francisco, and Sacramento. Regional differences have even emerged from one town to the next. Drinkers in Southern California clink their coconut shells with the Fijian wish of "bula," while those in Northern California toast with a simple English word, "rooted." One Sacramento-based company, Root of Happiness, owns entire kava farms across the Pacific: Papua New Guinea, Solomon Islands, Fiji, and Vanuatu. They provide materials to other kava bars across the U.S..

The kava phenomenon reaches far beyond California, with kava bars popping up in New York, Florida, Arizona, and Colorado. One company, Kavasutra, has 19 different locations in the country, while the brand Leilo sells a canned carbonated soft drink with kava.

One of the country's most vibrant kava scenes is found in Florida. I contacted Emily Edmonds of Oahu Kava Bar, located in West Palm Beach, Fla., who told me about the broad range of varieties they serve. "Currently we are offering Vanuatu and the Solomon Islands, but in the past, we have served Tongan Kava and Fijian kava as well. Our customers seem to enjoy kava from Vanuatu for its strength and smooth drinkable flavor."

In an article for *The New Yorker,* meanwhile, Carrie Battan describes the cultural significance of the kava scene in the Big Apple. "Increasingly, it feels as though New York is attempting to reconcile its booze-hounding tendencies with its newfound, almost Los Angelesque obsession with health and wellness." Battan describes kava bars as "a New York City experiment that asks its patrons to imagine the possibility of a cosmopolitan social life without alcohol."

TOO MUCH OF A GOOD THING

The more I read about kava, the more it sounded too good to be true. It was beginning to remind me of a scene in the 2007 comedy film, *Walk Hard: The Dewey Cox Story,* where one character gives an idealized description of marijuana. "It doesn't give you a hangover! It's not habit-forming! You can't O.D. on it!" This all sounded like kava, with the added benefit that it was entirely legal.

Could there be any downside to this miracle drug?

My friend Paul was the first to tell me that it was, indeed, possible to have "too much kava." During his visit to Vanuatu, he spotted a local man who had been drinking it all day. Paul watched the man spend at least ten minutes trying to step over an enormous log. He raised his leg high, then lowered it and stared at the ground with concern. Turns out, the "log" was just a tiny branch, not half an inch thick. The kava had completely distorted his depth perception.

Sione, as well, told me that he had known some folks who went overboard. Fijian kava drinkers, in particular, were known to drink highly concentrated kava. "My friend and I will have one kilo of kava powder in a huge gallon bowl of water, and that's more than enough. These guys from Fiji, though, they'll add three or four times that much."

One 2016 study in Fiji linked kava use with more automobile accidents. "Driving following the use of kava was associated

WHERE TO FIND KAVA

Warning: *According to the U.S. Food and Drug Administration, "kava-containing dietary supplements may be associated with severe liver injury." ("FDA Issues Consumer Advisory for Dietary Supplements Containing Kava," 2002.) Consult with your physician if you have any questions.*

Unlike other articles, I cannot offer any recipes here. Homebrewers would be ill-advised to include any kava in their beers, for all the reasons indicated above. Kava should not be combined with alcohol.

If you are interested in trying kava, however, you have several options. Kava extract can be purchased in powder and pill form in several markets and health food stores across the U.S., including some locations of Whole Foods and Sprouts. The Fiji-based company Pure Kava (purekava.com) is one of many offering exports directly from the South Pacific.

In the continental U.S., you can find commercial kava bars in states like California, New York, Florida, Arizona, and Colorado. Check your local listings.

The author samples kava at Gather Kava Bar in San Diego.

with a significant excess of serious-injury involved road crashes," the conclusion reads. "The precautionary principle would suggest road safety strategies should explicitly recommend avoiding driving following kava use, particularly in communities where recreational use is common."

Mark Twain himself witnessed the effects of kava abuse during his visit to Hawaii, calling it "fearful in its effects when persistently indulged in. It covers the body with dry, white scales, inflames the eyes, and causes premature decrepitude." Studies have confirmed that excessive kava use can cause patchy dermatitis, flaky and scaly skin. One 1988 study in Australia cited in Kilham's book examined heavy kava use by Aboriginal people in Arnhem Land. Heavy drinkers suffered "shortness of breath, dry, scaly skin, liver damage," as well as alterations to their red and white blood cells.

Given the potential for abuse, Australia is one of the countries that have started to regulate it. The Australian Capital Territory Government defines kava as a "prescription-only medicine" under the ACT under the Medicines, Poisons and Therapeutic Goods Act 2008, making an exception only for cultural rituals by Pacific Islanders. The national government banned kava imports in 2007. In December 2021, they finally began to release restrictions, although it is still illegal in the Northern Territory.

When I first began writing this article, I planned on making an experimental beer infused with kava. Surely it could be done, right? As long as the malt sufficiently masked the earthy taste of the kava, there would be no problem, would there?

As I learned of the downsides of kava, I thought twice about it. I decided to ask several brewers in Hawaii if anyone had tried brewing beer with kava. None of them had heard of it being done. Many of them mentioned the legal barriers involved, as kava is not an approved ingredient of the Alcohol and Tobacco Tax and Trade Bureau. During my visit to San Diego's kava bar, Derek put the final nail in the coffin of my idea.

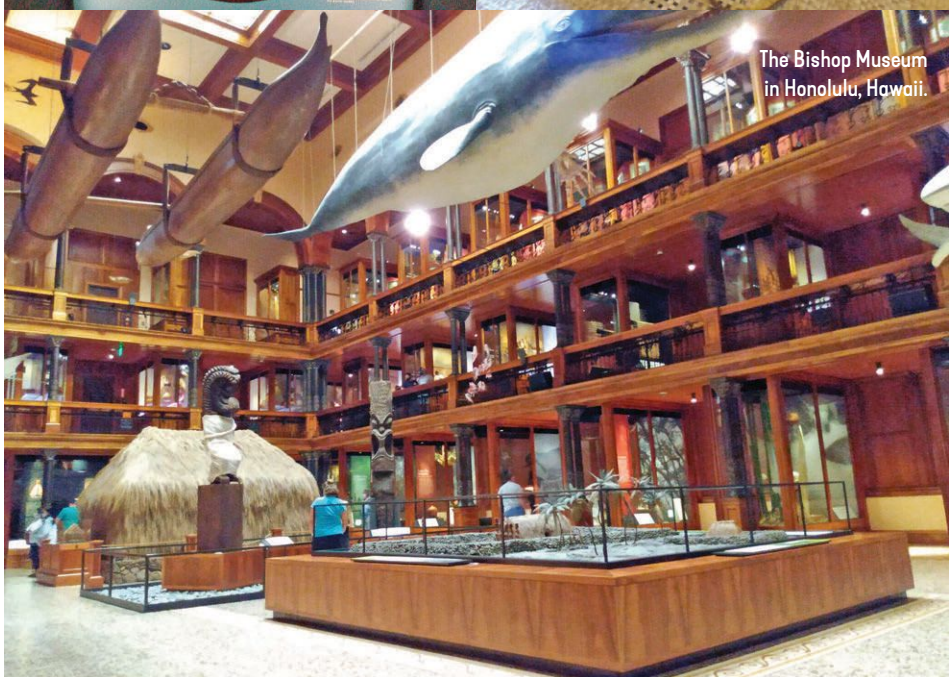
"It could be potentially dangerous," he said. "Kava and alcohol don't mix. I don't even serve customers here if I know they've been drinking alcohol."

He explained that the impact of the kava on the liver could be compounded by the alcohol. In addition, the combined alcohol and kavalactones would exponentially affect

Ulupō Heiau on the island of Oahu. Kava was an integral part of offerings made at ancient Hawaiian heiau (temples) like this one.

Traditional kava bowls in the collection of Hawaii's Bishop Museum.

Traditional kava bowls from across Polynesia, on display at the Polynesian Cultural Center.



The Bishop Museum in Honolulu, Hawaii.

the drinker. "It's like drinking when you're taking strong pain medication. Bad news."

The Food and Drug Administration of the United States has issued a similar warning. In 2002, they announced that "kava-containing dietary supplements may be associated with severe liver injury."

By and large, though, the negative effects aren't nearly as strong as those of other legal drugs. Even the 1988 Australian study should be put into perspective: most of its test subjects weren't *just* drinking kava. They were also heavy users of alcohol and tobacco, suffered from severe malnutrition, and lived in extreme poverty. The study was not able to separate kava use from these other factors.

To be sure, too much of a good thing is never a good thing. And yet, it's important to recognize the many therapeutic benefits that moderate kava use offers.

NATURAL MEDICINE FOR THE BODY AND MIND

Like many folk brews, kava is not only a sacred and social drink—it's folk medicine as well. Across the Pacific, it is used to relieve headaches and stomach problems, asthma, tuberculosis, and whooping cough, and to aid in urination. It is applied topically to treat fungal infections. Statistically, it is even associated with lower rates of gonorrhea!

Foreigners began experimenting with kava as medicine in the early 20th century. As Chris Kilham explains in his book, Europeans used it as a sedative in the 1920s, and the U.S. Dispensatory of 1950 used it to treat gonorrhea and nervous disorders. Japanese doctors were treating gonorrhea with kavalactones before World War II; by the 1980s, it was an ingredient of several Japanese and European pharmaceutical companies. Perhaps the most significant application, however, is for emotional and mental illnesses.

David Thompson noted the soothing effects of kava in his article, stating succinctly, "Fights don't break out at kava bars." During his many visits to Hawaii's kava bars, "unlike regular bars, where tempers can rise with the voices as the night wears on, the more people drink at a kava bar, the more hushed the place becomes. The later it gets, the greater the sense of peace and goodwill."

Western studies have shown the effectiveness of kava in treating anxiety, depression, and insomnia. A 1990 study found that the benefits of kavalactones were comparable to benzodiazepines, without the negative effects. Most notably, moderate kava use does not seem to impair physical coordination. A series of tests in 1993 found that use of kava extract did not affect performance in driving cars or operating machinery.

When I chatted with the regular customers of the kava bar in San Diego, I learned that many of them were recovering alcoholics. Some even described the drink in quasi-religious terms, referring to the moment in life "when I found kava." It offered them the pleasant, calming effects of alcohol, along with the social cohesion and enjoyable rituals of the bar, without the downsides. Many people who have struggled with alcohol abuse find kava to be a healthy, safe alternative.

JUST THE BEGINNING

Kava is on the rise, both as medicine and recreational social activity. I watched this happen in real time in San Diego. Every few minutes, a curious passerby would wander into the bar and ask about the strange new beverage. Derek described it with all the zealous conviction of a circuit-riding preacher. Often, the person would stay for a drink—another fresh convert made.

Meanwhile in kava's countries of origin, it continues to achieve new relevance, taking on new meanings and contexts. The authors of *Kava: The Pacific Elixir* summarize the myriad roles of the ancient plant:

Kava's traditional cultural meanings and social functions are now overlaid with new uses in the contemporary Pacific: kava as symbol of Christian atonement; kava as icon of the new state; kava as cultural fetish within developing nationalist discourse; kava as assertion of resistance and indigenous rights [...] kava as the shared pick me-up of urban Pacific kava bars. The story of kava is far from ended.

I can't help but think that the best days of the global kava boom are still ahead of us. So many countries still haven't even heard the good news about this unusual elixir. Mexico City, my adoptive hometown and one of the largest cities in the world, still has zero kava bars. (One location named "Kava Café" turned out to be just an ordinary coffee shop.) The same could be said for many other unfortunate cities around the world.

As the news of kava spreads, it can only bring good things in its wake. Let us all raise a coconut shell of goodwill for its success, as we cry "bula" together.

The best is yet to come.

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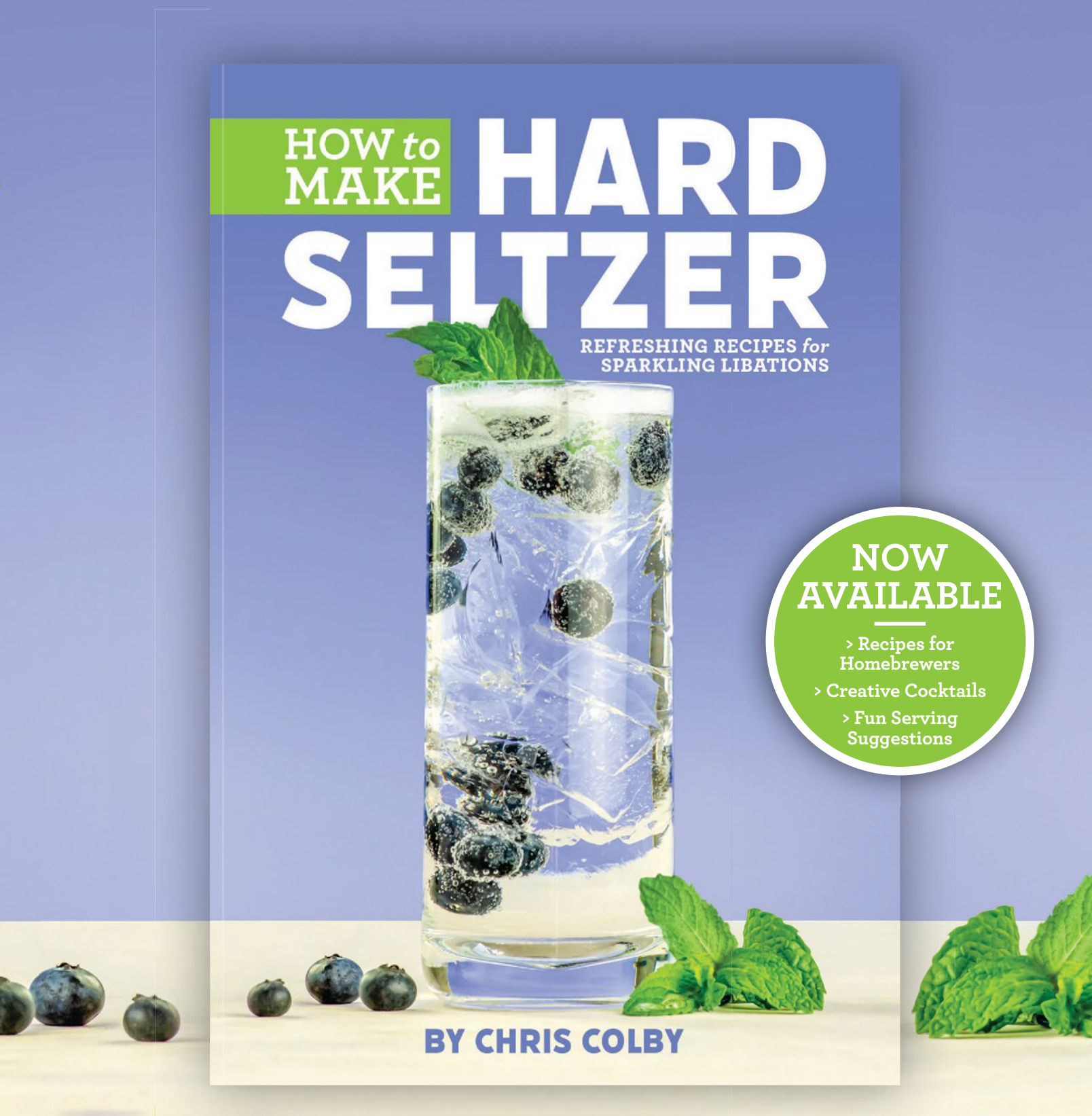
David J. Schmidt is an author, homebrewer, and multilingual translator who splits his time between Mexico City and San Diego, Calif. Schmidt speaks twelve languages and has spent the past fifteen years traveling throughout rural Mexico, Latin America, and Africa in search of ancient folk brews, making him a veritable Indiana Jones of homebrewing. (Think Harrison Ford with a beer gut.) He can be found on Facebook, YouTube, and Twitter with the handle "Holy Ghost Stories," or via his website HolyGhostStories.com.



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Relax, Don't Worry, Have a *Homebrew!*

That mantra rings as true today as it did in 1978 when Charlie Papazian cofounded the American Homebrewers Association with Charlie Matzen. Homebrewing can be as simple or as complex as you want to make it, but the first step is always to relax and not worry.

To aid your relaxation and help you get the most out of *Zymurgy*, here are some standard assumptions and methods for our recipes. Of course, when a recipe says to do something different, follow the recipe. But you can always fall back on these general tips to brew great beer.

ON THE WEB
For more detailed info, head over to HomebrewersAssociation.org and dive into our How to Brew resources.

BREWING WITH *ZYMURGY*

MAKING WORT

Most recipes in *Zymurgy* offer an all-grain version and a malt extract or partial-mash alternative. Pick the procedure you prefer and prepare some wort! Some recipes might include a water profile. If you can't (or don't want to) deal with water chemistry, don't worry about it: just go ahead and brew! Extract brewers needn't add minerals to water.

Malt Extract Recipes
Making wort from malt extract is easy.

- Crush specialty grains, if any.
- Place milled grains in a mesh bag and tie it off.
- Steep bag of grains in 150–160°F (66–71°C) water for 30 min. in your brew pot.
- Remove bag of grains from the pot.
- Fully dissolve extract in the hot, grain-infused water (if there are no specialty grains in the recipe, you can skip directly to this step).
- Top up with water to your desired boil volume. (Leave some room for foam!)

All-Grain and Partial-Mash Recipes
Unless otherwise specified, all-grain brewers can conduct a single-temperature infusion mash with these parameters:

- Water/grain ratio: 1.25 qt./lb. (2.6 L/kg)
- Mash efficiency: 70%
- Mash temperature: 150–153°F (66.7–67.2°C)
- Mash duration: 60 minutes

Partial-mash recipes make the same assumptions but use a smaller amount of grain and augment the wort with malt extract.

BOILING

No matter how you get here, everyone loves adding hops.

- Boil time is 60 minutes unless otherwise stated.
- Boils are assumed to be the full batch volume, but you can also boil a concentrated wort and top up with water in the fermenter.
- Hop additions are given in minutes before the end of the boil.

Photo © Jesse James Galarza

Brew Lingo

Every field has specialized language, and homebrewing is no different. Here are a some of the key terms, abbreviations, and acronyms you'll find throughout *Zymurgy*.

AA – alpha acid

ABV – alcohol by volume

AHA – American Homebrewers Association

BBL – US beer barrel (31 US gal or 117.3 L)

BIAB – brew in a bag

BJCP – Beer Judge Certification Program

Chico – American ale yeast, AKA Wyeast 1056, WLP001, SafAle US-05, and others

CTZ – Columbus, Tomahawk, and Zeus: interchangeable high-alpha-acid hops

DME – dry malt extract

DMS – dimethyl sulfide, an off flavor similar to canned corn or cooked vegetables

DO – dissolved oxygen

EBC – European Brewing Convention (beer color)

FG – final gravity

FWH – first wort hops, added to the boil kettle as it fills with sweet wort after mashing

HERMS – heat exchange recirculating mash system

HLT – hot liquor tank

IBU – international bittering unit

LHBS – local homebrew shop

°L – degrees Lovibond (malt color)

LME – liquid malt extract

LTHD – Learn to Homebrew Day

MLT – mash-lauter tun

NHC – National Homebrew Competition

OG – original gravity

°P – degrees Plato (wort/beer density)

RIMS – recirculating infusion mash system

RO – reverse osmosis, a water purification process that removes most dissolved ions

SG – specific gravity (wort/beer density)

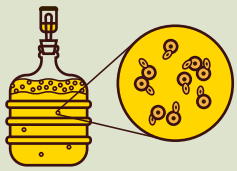
SMaSH – single malt and single hop

SMM – S-methyl methionine, precursor to dimethyl sulfide (DMS)

SRM – Standard Reference Method (beer color)

FERMENTING & CONDITIONING

Pitch yeast into chilled, aerated or oxygenated wort.



- Use twice as much yeast for lagers as you do for ales.
- Ales ferment at 60–70°F (15–20°C). Lagers ferment at 45–55°F (7–13°C).
- Condition ales at room temperature or colder for a week or two.
- Condition lagers at close to freezing for several weeks if you can (traditional but not required).

BOTTLING & KEGGING

If you bottle,

- Use 1 oz. of dextrose (corn sugar) per gallon of beer (7.5 g/L) for a good, all-purpose level of CO_2.
- Use less sugar for less fizz.
- Take care with higher carbonation levels—many single-use beer bottles aren't designed for high pressure.

If you force carbonate in a keg,

- Use the chart to dial in the gauge pressure on the regulator.
- Add 0.5 psi (35 mbar) for every 1,000 feet (300 meters) you live above sea level.
- To convert psi pressures to mbar, multiply by 69.
- To convert volumes of CO_2 to g/L, multiply by 2.

REGULATOR PRESSURES (PSI) FOR VARIOUS CARBONATION LEVELS AND SERVING TEMPERATURES

TEMP. (°F)	VOL. CO_2										
	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
33	5.0	6.0	6.9	7.9	8.8	9.8	10.7	11.7	12.6	13.6	14.5
34	5.2	6.2	7.2	8.1	9.1	10.1	11.1	12.0	13.0	14.0	15.0
35	5.6	6.6	7.6	8.6	9.7	10.7	11.7	12.7	13.7	14.8	15.8
36	6.1	7.1	8.2	9.2	10.2	11.3	12.3	13.4	14.4	15.5	16.5
37	6.6	7.6	8.7	9.8	10.8	11.9	12.9	14.0	15.1	16.1	17.2
38	7.0	8.1	9.2	10.3	11.3	12.4	13.5	14.5	15.6	16.7	17.8
39	7.6	8.7	9.8	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5
40	8.0	9.1	10.2	11.3	12.4	13.5	14.6	15.7	16.8	17.9	19.0
41	8.3	9.4	10.6	11.7	12.8	13.9	15.1	16.2	17.3	18.4	19.5
42	8.8	9.9	11.0	12.2	13.3	14.4	15.6	16.7	17.8	19.0	20.1

= PSI

Source: Brewers Association Draught Beer Quality for Retailers

What's in a Unit?

Ode to the Mars Climate Orbiter

Photos © Getty/Stocktrek Images

By Eric J. Wahlberg

At the end of September 1999, NASA lost its Mars Climate Orbiter. According to the *Los Angeles Times*, the thrusters used to put the spacecraft into orbit were programmed using incorrect units. The thrusters fired and, instead of reaching orbit, the spacecraft crashed into the Red Planet. Project cost? More than three hundred million dollars. →

Having spent years training wastewater treatment plant operators, a sinking sense of *déjà vu* struck me as I read Jason Simmons's article, "So, You Want to Go Pro?" in the Nov/Dec 2021 issue of *Zymurgy*. These are the sentences that hit me hardest:

> How are your algebra and science skills? Does "Please Excuse My Dear Aunt Sally" sound familiar? How about volume, weight, and temperature conversions? This science-based industry relies heavily on math that, done incorrectly, costs a brewery money, time, and deadlines. In the worst cases, **such errors could injure or even kill someone.**

The bold emphasis is mine. Obviously, what we're talking about here is very important.

EVERYTHING IN ORDER

Let's begin with a math problem. What does x equal given the following?

$$x = 24/12/2$$

Some people "see" the answer as 4. Twelve divided by 2 is 6, and 6 into 24 is 4. Unfortunately, 4 is *wrong*. Remember in third grade, your teacher instructed you to "invert and multiply" when you have a fraction in the denominator? If you incorrectly calculate the answer as 4, then you're first inverting the fraction 12/2 and evaluating the expression like this:

$$x = 24/12/2 \neq 24 \times (2/12) = 48/12 = 4$$

That approach is out of order. The "rules" of mathematics are well established and not open for interpretation. The applicable rule in this case is to perform the operations left to right: 24 divided by 12 is 2, and 2 divided by 2 is 1:

$$x = 24/12/2 = \frac{24}{12} \div 2 = 2 \div 2 = 1$$

Considered another way,

$$x = 24/12/2 = \frac{24 \div 12}{2} = \frac{24}{12 \times 2} = 1$$

This is the correct answer. More importantly, however, is understanding that the second division from the left in the original problem statement is not division—**it's multiplication!** With the rules of math, there really isn't any ambiguity with the double slash, but people get it wrong all the time. I don't use it.

Math is incredibly important (tell your children this at dinner tonight and never, ever let them skate on math). The problem is many of us struggle with math. Some of us, so thoroughly confused by math, stifle our own careers, or change career paths altogether, to avoid it.

There is no human gene or trait that makes one "bad at math," and I believe, with plenty of evidence, that the source of our math avoidance is how we are taught math and the language of math used by people we look up to. Those who are "good" at math—forgetting how difficult math is for so many—use mind-numbing shortcuts and erratic arm-waving to demonstrate how "easy" math is. This is painfully obvious when people either don't use units or combine a string of units into a dyslexic hodgepodge of alphabet soup.

WHO IS AUNT SALLY?

If it's been some time since your last math class, you might be wondering about Aunt Sally and what she's done to warrant excusing. "Please Excuse My Dear Aunt Sally" is a mnemonic to help students (and homebrewers) remember the order of mathematical operations.

Please	**P**arentheses
Excuse	**E**xponentiation
My **D**ear	**M**ultiplication and **D**ivision
Aunt **S**ally	**A**ddition and **S**ubtraction

Some folks eschew Aunt Sally altogether and just remember the made-up word *PEMDAS*. Readers who studied math (maths) in Commonwealth countries may be more familiar with *BEDMAS*, *BIDMAS*, or *BODMAS*, where *B* (*brackets*) replaces *P*, and *O* (*order*) or *I* (*index*) stands in for *E*.

Multiplication and division share equal priority. Addition and subtraction are also on equal footing. Operations of equal stature are considered from left to right in the order in which they appear in the expression, which is why 24 ÷ 12 ÷ 2 = 1, not 4.

GET TO THE POINTS! (PER POUND PER GALLON)

Which brings me to PPG, defined in our business as "points per pound per gallon." If "gravity points" (i.e., "points") are expressed using the unit "P," then PPG has the units P/lb./gal., in compliance with the previous sentence. (Metric: PKL, "points per kilogram per liter," P/kg/L.) For example, liquid malt extract (LME) has a typical yield of 36 PPG, or 36 P/lb./gal. (300 P/kg/L).

Oh no, the dreaded double slash is back!

If we apply the non-negotiable math rule cited above, the LME yield is correctly expressed as 36 P / (lb. · gal.), or 300 P / (kg · L), where the dot operator (·) indicates multiplied units rather than the multiplication sign (×).

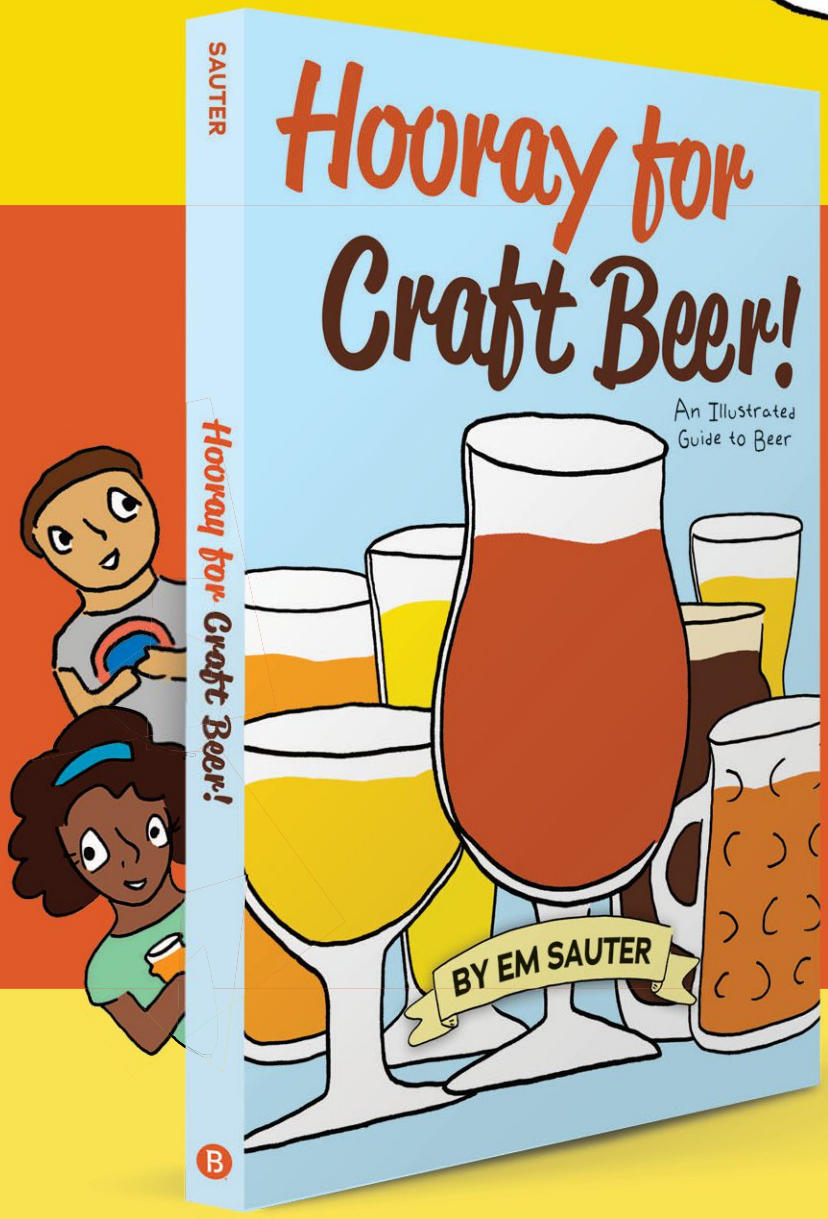
But, *no*, LME yield is actually 36 P · gal. / lb. (300 P · L / kg)! Somewhere along the line, someone interpreted the double slash to their own liking, completely indifferent to the rules of math. Why does math have rules? So we all do it the same way.

Although quite obsessed with homebrewing, I am a total neophyte with just a year under my belt. Without knowing a lot of brewing history, I don't know where or by whom the concept of "gravity points" originated, but I think it's ingenious. It's also super important to homebrewers so it warrants "getting it right."

John Palmer's wonderfully comprehensive *How To Brew* includes an example using the "mass gravity volume equation" where the amount of LME needed to make 6 gallons of wort with a specific gravity of 1.056 is calculated. This specific gravity is equivalent to 56 P using the unit introduced above. LME has a yield of 36 P · gal. / lb. (300 P · L / kg). From page 52 of my copy of *How To Brew* is the following sequence, exactly as printed:

X lb. × 36 PPG = 56 gravity points × 6 gal.

Rearrange to give
X lb. = (56 × 6)/36
= 336/36
= 9.3 lb.



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John, of course, gets the correct answer, but this sequence feels and looks like arm-waving to me, mostly because I can't follow the units (I'm thinking, "Mars Climate Orbiter"). Math is so much easier when units are used every step of the way. Here's my version.

Given
- a **target original gravity** of 1.056 (56 P),
- a **typical LME yield** (with units stated correctly) of 36 P·gal./lb. (300 P·L/kg),
- and a **wort volume** of 6 gal. (22.7 L),

solve for
- the necessary **weight of LME** in lb.

Solution:

$$[\text{lb.}] = \left| \frac{\text{lb.}}{36\ \text{P} \cdot \text{gal.}} \right| \frac{56\ \text{P}}{} \left| \frac{6\ \text{gal.}}{} \right|$$

= (lb. × 56 P × 6 gal.) ÷ (36 P·gal.) = **9.3 lb.** (4.2 kg)

The units needed in the answer are placed between square brackets on the left-hand side of the equals sign to guide your progress across the solution bridge on the right-hand side. Then you write down each of the important quantities in such a way that anything not on the left side cancels. A unit cancels when the same unit is found on both the top and the bottom. In this case, points (P) and gallons (gal.) cancel.

Known as *dimensional analysis*, using units to solve math problems is gigantically helpful. Units will tell you how to start a problem (yield was entered upside down—division—on the bridge to get the unit lb. on the top needed in the answer) and whether to multiply or divide by any constant, variable, or conversion factor (both the target points and wort volume were entered on the top—multiplication—to cancel unwanted units on the bottom). They'll even do algebra for you (no more "let *x* equal…")!

A WATER CHEMISTRY EXAMPLE

Here's another brew-applicable calculation to see how the solution bridge works. How many grams of calcium chloride ($CaCl_2$) are needed in 5.5 gal. (20.8 L) of distilled water to achieve a calcium concentration of 100 mg/L? My first introduction to dimensional analysis was in high school chemistry, so this question conjures a lot of nostalgia, although there is a lot about high school I'd rather not remember (just saying).

Calcium chloride is commonly available in anhydrous (fully dehydrated) and dihydrate (bound to water) forms. For this example, let's assume we're working with calcium chloride dihydrate, whose chemical formula $CaCl_2 \cdot 2H_2O$ indicates that every molecule of $CaCl_2$ is bound to two water molecules. The relevant information is as follows:

Chemical formula of calcium chloride:	$CaCl_2 \cdot 2H_2O$
Atomic weight of Ca:	40
Atomic weight of Cl:	35.4
Atomic weight of H:	1
Atomic weight of O:	16
Molecular weight of $CaCl_2 \cdot 2H_2O$:	40 + (2×35.4) + (2×2×1) + (2×16) = 146.8
1 g	= 1,000 mg
1 gal.	= 3.7854 L

Now, given
- a **target Ca concentration** of 100 mg/L,
- in a **volume** of 5.5 gal. (20.8 L),

solve for
- the necessary **mass of $CaCl_2$** in g.

We'll use $CaCl_2$ as shorthand for $CaCl_2 \cdot 2H_2O$. The solution is given by

$$[\text{g } CaCl_2] = \left| \frac{100\ \text{mg Ca}}{\text{L}} \right| \frac{\text{g}}{1{,}000\ \text{mg}} \left| \frac{\text{mole Ca}}{40\ \text{g Ca}} \right| \frac{\text{mole } CaCl_2}{1\ \text{mole Ca}} \left| \frac{146.8\ \text{g } CaCl_2}{\text{mole } CaCl_2} \right| \frac{3.7854\ \text{L}}{\text{gal.}} \left| \frac{5.5\ \text{gal.}}{} \right|$$

= g $CaCl_2$ × 100 mg × 146.8 g × 3.7854 L × 5.5 gal. ÷ 1,000 ÷ 40 = **7.6 g $CaCl_2$**.

The solution bridge in this example starts with the target calcium concentration, 100 mg Ca/L, but these aren't the units we're solving for. The "trip" across the bridge entails canceling the units we don't need until the only units remaining are those we do need, g $CaCl_2$ (again, shorthand for g $CaCl_2 \cdot 2H_2O$). Note that the units tell us what to do; the numbers just come along for the ride until it's time to pick up the calculator!

The solution bridge takes some practice, but once mastered, it works every time, and the spacecraft goes into orbit. And so, too, will your brews.

But to make things right, to make math easier for homebrewers, a very simple place to start would be to replace PPG with PGP (points-gallons per pound) and PKL with PLK (points-liters per kilogram) because PPG (PKL) is a math-rule violation. Maybe math wouldn't be so hard if we all followed the rules.

Eric Wahlberg lives in Cabot, Vt., with his wife Patti and their two dogs.

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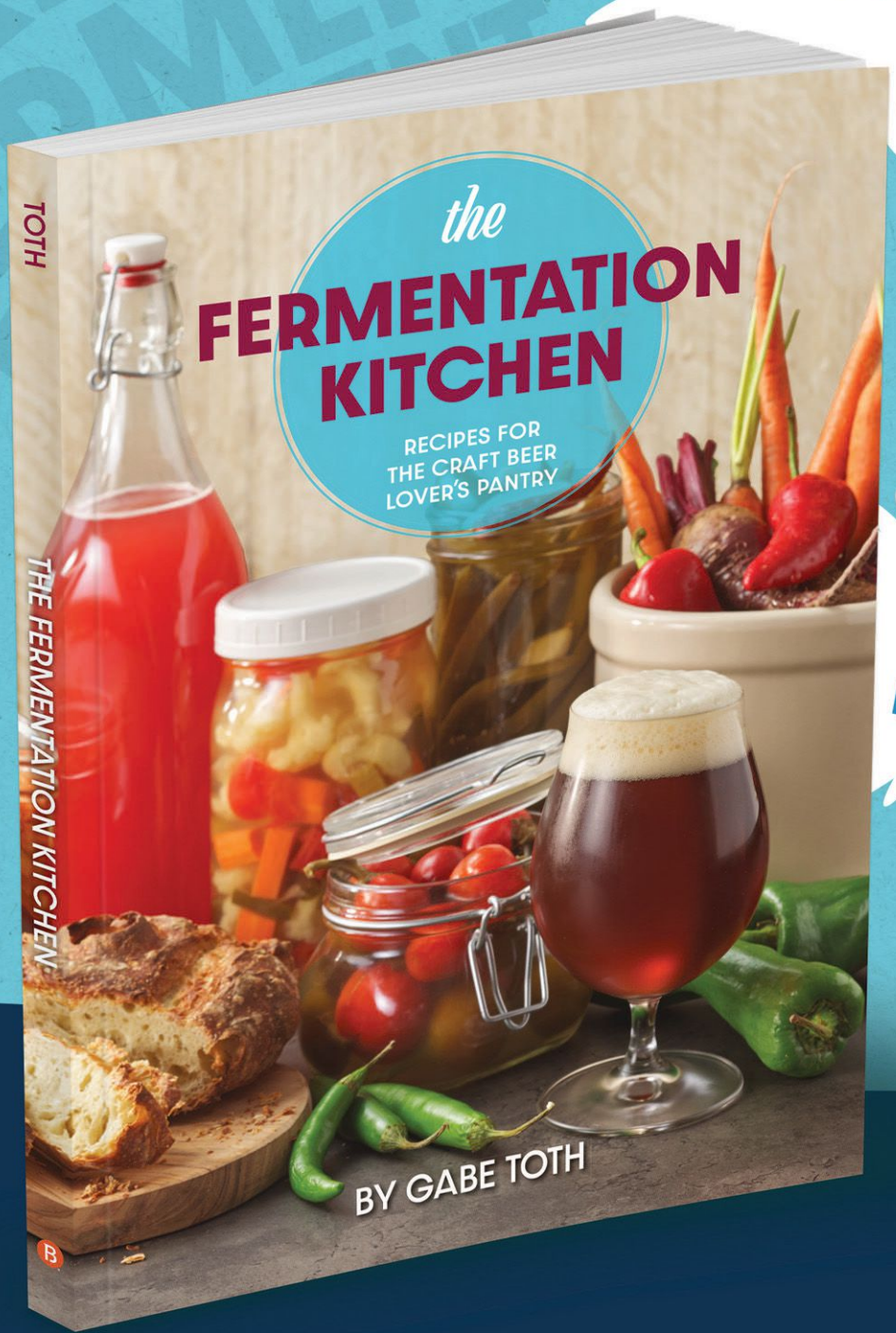

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Boot Brew Fest

Where Beer and Cajun Culture Collide

By Dustin Henry, with edits by Ken Duffy and Paul Pitre

In July 2020, my family and I moved to Louisiana. We had lived on the West Coast, on the East Coast, and in Texas, but Louisiana was new and different. It offered the Southern charm I had come to know and love in Texas, but the food was completely different. I spent my first six months asking friends, neighbors, and colleagues how to say names such as Theriot, Boudreaux, Thibodeaux, Port Fourchon, Lake Pontchartrain, Amite River, boudin, and, my favorite, La Place.

French and Spanish officials left Louisiana long ago, but their legacy lives on, not only in names, but in food, festivals, and music. Louisiana's 400 annual festivals have earned it the title of "Festival Capital of America."

With so much partying, it's notable that Louisiana's annual per-capita alcohol consumption of 2.55 gallons is only slightly higher than the national average of 2.47 gallons, which made me wonder how much more room there was for beer adventures in Louisiana. There's a strong base of alcohol consumers and a culture built around food and festivals, but the beer scene is not strong here.

Why do I say that? According to 2020 data from Statista, Louisiana ranked second to last among states for number of breweries per capita, with only 1.3 breweries per 100,000 adults aged 21 years and older. Vermont came in first, with 15.4 breweries, an indecisive consumer's nightmare. There are plenty of drinkers and plenty of opportunities to drink, but there aren't that many breweries.

Beer came to Louisiana through New Orleans from German immigrants in the 1720s. The 1850s brought more Germans and beer yeast from the homeland, but then the Civil War put it on hold. Beer reemerged after the war, but it wouldn't be until 1869, when artificial refrigeration was introduced to New Orleans, that the brewing industry would become strongly reestablished. Shreveport became known as the "Milwaukee of the South." Then the temperance movement came along, and Shreveport voluntarily went dry 12 years before Prohibition. More than a century would pass before another Shreveport brewery would open.

So, to our rebel brewers at Abita, Istrouma, Port Orleans, Bayou Teche, Agile, Great Raft, Crying Eagle, and the many others in the state, you're doing a phenomenal job.

This brings me to Paul Pitre (his last name is pronounced "Pete"), whom I met at Redstick Brewmasters in Baton Rouge. Paul was organizing the inaugural Boot Brew Fest in spring 2021 and was advertising in the club. Leading up to the festival, there would be a BJCP-sanctioned homebrew competition. On the day of the festival, there would be music, food, and a plethora of homebrewed beer. With a focus on highlighting homebrewing, attendees were encouraged to vote for their favorite beer for people's choice and best tent awards presented at the event. All of it would be held at Lakeview Park & Beach in Eunice, which is in Cajun Country.

At the Redstick Brewmasters meeting following the festival, Paul and several members who attended the festival were proud to admit that the inaugural Boot Brew Fest was a hit.

In early 2022, I sat down with Paul when he declared that the Boot Brew Fest was going to be held again in Eunice on April 22, 2022. I asked Paul what made him want to put it on and he told me he wanted to promote homebrewing to people in Louisiana. With so many proficient cooks, it made sense they might want to apply their skills to making beer.

Paul's family-owned Lakeview Park & Beach offered sprawling areas for tent camping, spots for RVs, and cottages for rent. What set the Boot Brew Fest apart from other festivals is the Cajun influence. All Cajun bands are booked, and all Cajun foods are cooked. This meant Cajun and zydeco bands coupled with shucked oysters, crawfish étouffée, cracklins, boudin, and jambalaya—a to-die-for smorgasbord. About 250 to 300 people attended in 2021 and 2022.

I encourage anyone who can come to the next Boot Brew Fest to do so. It's held on the weekend following Easter Sunday. Get out here and enjoy the most unique festival you will ever attend!

Dustin Henry is a USAF veteran, graduate of St. Louis University's Brewing Science & Operations program, and a brewing enthusiast.

Photos courtesy of Ken Duffy & Laura Pitre

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