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THE MAGAZINE OF THE AMERICAN HOMEBREWERS ASSOCIATION

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Beginner's Mind

In the classic bestseller *Zen Mind, Beginner's Mind*, the late Shunryu Suzuki observes, "The most difficult thing is always to keep your beginner's mind."

This was illustrated to me in a very real and viscous manner a month or so ago when I varnished the surface of my kitchen stove with a generous layer of hot wort. I cannot describe to you the sound of one hand clapping, but I can definitely relate the sound one man makes when the brew kettle boils over. That sound is laced with profanity and not suitable to lay down on these pages.

The brew day started out well enough. I hadn't done an extract recipe in some time, so I decided to whip up a quick homage to Timothy Taylor's Landlord using pale malt extract, a bit of English caramel malt, Styrian Goldings, and one of my favorite yeasts of all time, Wyeast 1469 West Yorkshire Ale (Wyeast, if you're reading this, first, thank you for supporting *Zymurgy*, and second, don't ever stop selling 1469).

Everything was going according to plan. Specialty grains? Crushed, bagged, and steeped. Malt extract? Dissolved. Boil? Rolling. Time for some bittering hops!

Of course, you know what happened next. A bit of beginner's mind could have been helpful. In forensically analyzing the cascade of events leading to the boil over, I can identify several mistakes that I would have been less likely to make in my earlier days.

1. I filled the pot to within a couple of inches of the rim for what was, in retrospect, no good reason. Don't ask me why. I just did.
2. My spray bottle of water, which I mainly use to irrigate the cat when he makes summit attempts on the curtains, was on the counter and not in my hand. Yes, I spray foamy hot break using the same bottle with which I fail to train my cat.
3. I didn't lower the heat before dropping in the hops. This was just dumb.

Photo © Getty/butenkow

New homebrewers enjoy a distinct advantage over those who have been brewing for years in that everything is new. Beginners pay close attention to details that many of us have forgotten or no longer bother to consider. A first-time homebrewer's worry over contamination is inversely proportional to the likelihood they'll actually experience it. It's veteran brewers who really should be more concerned.

I stopped taking hydrometer readings on extract batches a while ago, the rationale being that I know exactly how much malt extract is going into a fixed volume of wort. Provided you've designed the recipe correctly, you *have* to hit gravity, right?

Probably, but not necessarily. If some of your extract boils out of the kettle and forms a layer of shellac on the stove, it is, by definition, not going into your beer. If you use liquid malt extract and aren't particularly overzealous with the hot water, there's a nonzero chance some stubborn sugars will remain stuck inside the container.

When it comes to dried malt extract, aka the Devil's powder, pouring it into steaming wort creates those little maltose stalactites that hang from the lip of the bag. On certain dark, quiet nights, when the moon is a ghostly galleon, some say you can still hear our forebears scraping DME nuggets from the walls of their spectral kettles. (Don't get me wrong—I do actually love DME. I always keep some on hand for making starters, boosting gravity, and grouting tile.)

My point is that every now and then it does one good to take a step back, reexamine one's processes, and challenge one's assumptions. Why do farmhouse brewers in Stjørdalen, Norway, scream when they pitch yeast? You tell me. But if doing so yields consistently better beer, I'll gladly yell at the wort.

Less superstitiously, I've resumed hydrometer readings again for my extract batches. Even if doing so does little more than make me more aware of the process, it's worthwhile and considerably less costly than a new gas range.

I encourage you to read this issue of *Zymurgy* with a beginner's mind. You'll learn (or review) how to calculate mash infusions without software. You'll discover a sophisticated way to monitor fermentation progress. You'll gain an understanding of the basic tenets of good meadmaking. And you'll learn to make sake using about as traditional a process as a homebrewer is likely to want to perform.

Consider your brewing practice with a beginner's mind. You may very well find that it translates into a bit of beginner's luck.

Dave Carpenter is editor-in-chief of **Zymurgy.**

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Features

WHY I BREW WITH BRIESS

When we asked Paul at Central Waters Brewing Co. why he brews with Briess he replied, **"Because you can't make good beer without good malt,"** and we couldn't agree more. This is why we carefully monitor our barley supply chain from grower to brewer to ensure you **get the highest quality and most consistent specialty malt every time.**

Watch Paul tell us Why He Brews with Briess
BrewingWithBriess.com/CentralWaters

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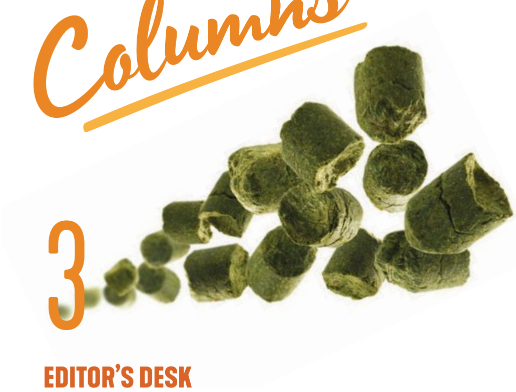

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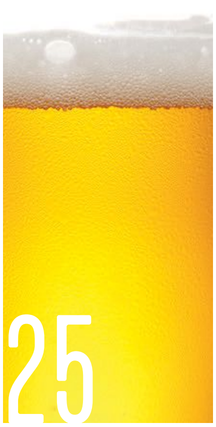

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Recipe Guide

Cover Photo
Luke Trautwein

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

ON THE WEB
Find these homebrewing recipes and more on our website @ HomebrewersAssociation.org/homebrew-recipes

NOW ON Tap

Roger Briess

MALT PIONEER ON A MISSION

By Ron Schroder, Briess Malt & Ingredients Co.

April 25, 2021, marked the 20th anniversary of the passing of Roger Briess, fourth-generation owner and leader of Briess Malt & Ingredients Co. Roger was a visionary who believed deeply in craft beer and knew the importance of high-quality specialty malt. He fiercely advocated for cooperation and partnership in the craft beer industry, a message that has always been a hallmark of the industry and continues to be amplified by the Brewers Association, parent organization of the American Homebrewers Association (AHA).

AHA founder Charlie Papazian described Roger as "the first craft maltster who was accessible to craft brewers. He offered malt in packages that were usable by small craft brewers." Charlie noted that "95 percent of craft brewers started by homebrewing, and Roger was the counterpart of that in the supply industry."

In the early days, there was a high level of uncertainty in the craft beer industry, including financial instability for many small breweries. Charlie noted that "Roger took risks supplying product to brewers, not knowing whether they would be able to pay." Roger was passionate about the success of craft brewers, and he was willing to accept additional risk for his business to help his customers succeed.

David Grinnell, vice president of brewing and quality at Boston Beer, said, "In the early days, Briess was the only game in town. At Boston Beer, we were so immature as a company. Roger was there holding our hands. … The craft brewing revolution went on as long as it did because of Roger Briess."

Roger was an eclectic person with a wide range of interests, from classical music to woodworking. Dan Carey, brewmaster at New Glarus Brewing, appreciated that Roger "always looked you in the eye and genuinely liked people." David Grinnell said Roger was "gracious, generous, and a good host." Charlie Papazian characterized him as a "pioneer and explorer."

Early in his career, Roger trained at Weihenstephan in Germany. He had a deep appreciation for traditional brewing methods, which were a springboard for his exploration into the range of possibilities for malt and craft beer. When third-generation maltster Eric Briess died in 1971, Roger assumed leadership of the company. He understood that malt was the heart of the brewing process, and he dedicated his life to sharing that passion with others.

Twenty years after his death, Roger's vision is still part of everything we do at Briess. The next time you visit a taproom, bar, or restaurant, order your favorite craft beer and raise a glass to Roger Briess and all those who had the vision and dedication to create the craft beer industry we know and love.

To read more about Roger Briess, visit HomebrewersAssociation.org.

From the AHA Director

IT'S ALIVE!

I hope you enjoyed the mad scientist on the cover this month. That's George Myler, the warehouse wizard who's been shipping AHA goodies to members for more than 20 years. When there aren't hops and grain on George's scale, it's the latest Brewers Publications® title getting ready for its shipping label.

When I think about mad scientists, the first place my mind goes is Dr. Frankenstein. While he had the requisite madness to be our archetype, he was also obsessively dedicated to a singular focus. He studied hard and stuck with the same problem until he solved it. Of course, if you know much about the story, things didn't go so well from there.

As you dive into this issue focused on the science of homebrewing, I challenge you to reanimate your brewing curiosity. If you are someone who tends to brew a recipe once and move on to the next, channel the obsessively single-minded scientist and brew it a second time. Have fun with the repetition of that experiment. Take note of what changes and what the impact on the final product is.

If you're someone who tends to dial in one recipe and brew it over and over to refine and hone it, I encourage you to take the reins off and run wild with a series of one-off batches. Play with the creativity and variety. And if you find yourself screaming, "It's alive! It's alive!", you know you've been watching too many movies.

Cheers, Ryan Farrell

Photo courtesy of Briess Malt & Ingredients Co.

Brew This!

Black Is Beautiful Imperial Stout

(COUNTDOWN BREWING VERSION)

BLACK IS BEAUTIFUL

Recipe courtesy of Steve Ruch.

Marcus Baskerville, head brewer and cofounder of Weathered Souls Brewing Co. in San Antonio and keynote speaker for Homebrew Con 2021, started the Black Is Beautiful initiative to support organizations that build positive, equitable communities. Participating breweries around the world brew their own riffs on the beer and donate 100 percent of proceeds to local foundations that support police brutality reform and legal defenses for those who have been wronged.

AHA Governing Committee member Annie Johnson adapted the commercial recipe for homebrewers, which is available at HomebrewersAssociation.org. The recipe you see here adopts Steve Ruch's Countdown Brewing approach (see page 80) to yield an even simpler formulation that uses just a handful of readily available ingredients.

Batch volume: 3 US gallons (11.4 L)
Original gravity: 1.088 (21.1°P)
Final gravity: 1.022 (5.6°P)
Color: 50 SRM
Bitterness: 82 IBU
Alcohol: 8.8% by volume

MALTS

8.5 lb.	(3.86 kg)	Maris Otter pale ale malt
1.5 lb.	(680 g)	American roast barley
8 oz.	(227 g)	British crystal 160 malt

HOPS

1 oz.	(28 g)	Columbus, 13% a.a. @ 60 min
1 oz.	(28 g)	Cascade, 4.5% a.a. @ 20 min
1 oz.	(28 g)	Cascade, 4.5% a.a. @ 10 min

YEAST

2 sachets Lallemand BRY-97 American West Coast Ale Yeast

ADDITIONAL INGREDIENTS

10 oz. (284 g) corn sugar

BREWING NOTES

Mash grains for 60 minutes at 150°F (66°C) with a mash thickness of 1.5 qt./lb. (3.1 L/kg). Vorlauf until clear and sparge with enough water to collect 3.5 gal. (13.3 L). Bring to a boil, stir in corn sugar, and boil 60 minutes, adding hops as indicated. After 60 minutes, remove from heat and chill to 66°F (19°C). Rack to fermenter and pitch yeast. Ferment at 66°F (19°C) for 3 weeks and bottle. Age for a while (if you can).

EXTRACT VERSION

Replace the Maris Otter malt with 6 lb. (2.7 kg) Maris Otter liquid malt extract. Steep the roast barley and crystal malt in 2 qt. (1.9 L) of 151°F (66°C) water for 20 minutes. Remove grains, add 3 gal. (11.4 L) water and heat to near boiling. Thoroughly mix in the extract, bring to a boil, and proceed with the recipe as written above.

ON THE WEB

Visit BlackIsBeautiful.beer to learn more about the Black Is Beautiful initiative and to download commercial and homebrew recipes for Black Is Beautiful imperial stout.

Yeast Selection for Cider

By Etienne Dorignac, technical manager, fruit fermentation, Fermentis

Cider depends on a number of factors, among them country of origin, must composition, other fruit additions, and usage of juice, concentrates, or external sugars. Recipes hugely differ, which makes a standard study almost impossible.

Fermentis set out to select four new cider yeast strains and to characterize them using four recipes that encompass the main problems faced by cidermakers around the world: types of apples used, source and quantity of sugars, fermentation temperature, and whether fermentation completed naturally or was forced to stop. All fermentation tests were carried out at the experimental cellar of the Institut Français des Productions Cidricoles (IFPC), a French research institute that specializes in cidermaking. Experiments took place in 15-liter glass vessels with a standardized oxygen infusion of 1.5 mg/L under an inert atmosphere of pure nitrogen. →

TABLE 1: Types and characteristics of the cider recipes used in the study. Bittersweet apples are high in tannins and low in acidity. Sweet apples are low in both tannins and acidity. DAP is diammonium phosphate, a source of ammonium ions. SpringFerm and SpringFerm Xtrem represent, respectively, partial and total yeast autolysates as sources of amino acids, lipids, vitamins, and other oligoelements.

TYPE OF CIDER	TRADITIONAL FRENCH SWEET CIDER	TRADITIONAL ENGLISH DRY CIDER	FRENCH DRY CIDER FOR DISTILLATION	AMERICAN DRY CIDER
Must composition	100% apple	100% apple	100% apple	50% apple juice concentrate 50% glucose
Type of apples	Bittersweet	70% Sweet 30% Bittersweet	Bittersweet	Sweet
Sugar concentration	119.5 g/L	129.9 g/L	145.3 g/L	209.4 g/L
Sugar composition	56% fructose 14% glucose 30% sucrose	63% fructose 21% glucose 16% sucrose	52% fructose 16% glucose 32% sucrose	63% fructose 29% glucose 8% sucrose
Potential ABV	7.1%	7.7%	8.6%	12.4%
Yeast available nitrogen (YAN)	110 mg per liter of must 0.92 mg per gram of sugar	127 mg per liter of must 0.98 mg per gram of sugar	126 mg per liter of must 0.86 mg per gram of sugar	90 mg per liter of must 0.43 mg per gram of sugar
Pre-fermentation sulfites	No	50 mg/L	No	No
Pre-fermentation pH adjustment with malic acid	No (pH 3.5)	Yes (pH 3.6)	No (pH 4.0)	Yes (pH 3.6)
Yeast pitch rate	10 g/hL	10 g/hL	10 g/hL	10 g/hL
Nutrient additions	None	20 g/hL SpringFerm on day 3	None	30 g/hL DAP and 20 g/hL SpringFerm Xtrem on days 0 and 3
Fermentation temperature	10°C (50°F)	18°C (64°F)	10°C (50°F)	18°C (64°F)
Fermentation end	Forced stop at SG of 1.013 (32 g/L residual sugar), 5% ABV, by microfiltration	Until dry	Until dry	Until dry

STRAIN CHARACTERIZATION

Table 1 characterizes the four recipes considered. As we move from the traditional French sweet cider to the American hard dry cider, fermentation conditions becoming increasingly difficult even though nutrition and temperature are adjusted. It was thus interesting to try different yeast strains through all these recipes to select the most diverse and interesting ones.

From more than 20 strains evaluated, we'll highlight the main results for four of them: SafCider AB-1, SafCider TF-6, SafCider AS-2, and SafCider AC-4.

Robustness

We assessed the robustness of the strains under difficult fermentation conditions (i.e. high sugar concentration) and concentrations of the most difficult to assimilate fermentable sugars (i.e. fructose), low pH, nutrient deficiency, and low temperature. Figure 1 illustrates the kinetics and final gravity at the end of fermentation for the American dry cider.

The strain SafCider TF-6 clearly stands apart from the other strains in that it was unable to complete the fermentation and typically left about 25 g/L of sugars, among which fructose was a major component. This feature was observed in most of the ciders, and TF-6 was only able to ferment to dryness in the English cider—high YAN, low tannins, higher temperature—which highlights the needs of this particular strain and demonstrates that yeast selection can be crucial, depending on the cidermaker's target. This strain is also notable for its sensitivity to high concentrations of sulfur dioxide (SO_2), up to 50 mg/L maximum.

Analytical Profile

All basic analytical parameters at the end of fermentation were measured, but acidity is of particular interest because it reflects metabolic behavior that can have a real impact on the organoleptic profile of the finished cider.

Figure 2 shows the acidity profiles of the four strains for the English cider recipe.

FIGURE 1: AMERICAN DRY CIDER FERMENTATION KINETICS

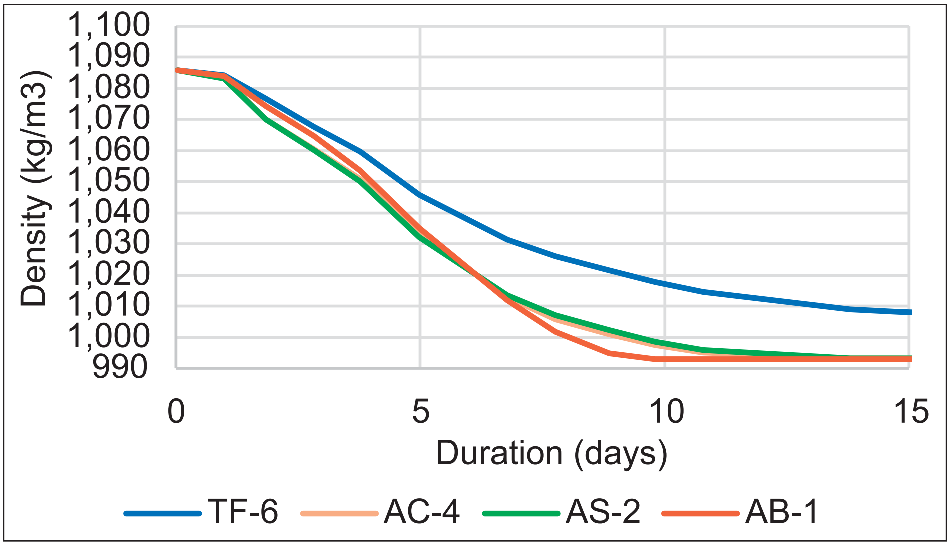
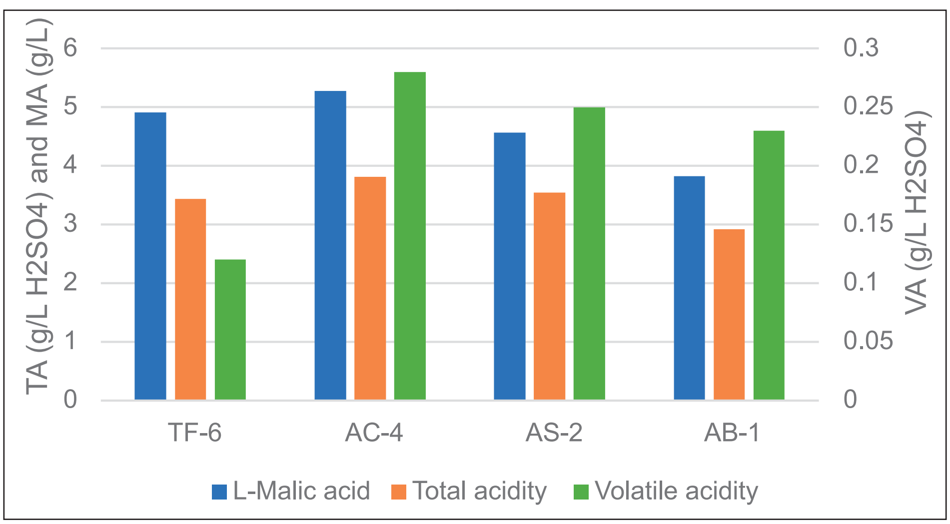


FIGURE 2: ACIDITY PROFILES FOR ENGLISH DRY CIDER



Most significantly for SafCider AB-1, we see that some strains can consume malic acid, the major organic acid present in apples, in significant amounts through the malo-ethanolic pathway, which decreases total acidity and the perception thereof.

On the contrary, some strains, such as SafCider AC-4, preserve this acidity and maintain a crisp mouthfeel. Moreover, some strains can produce acetic acid in the glycolysis pathway during fermentation, which can affect the overall aromatic profile, even degrading its quality at too high a concentration. All strains were selected for their low acetic production, and SafCider TF-6 is notable as a "clean" strain with low SO_2 and acetaldehyde production.

Aromatic Profile

In addition to higher alcohols, yeasts produce two major types of aromatic compounds during fermentation that significantly affect the aromatic profile of all beverages: (1) acetate esters, the most famous and abundant of which is isoamyl acetate (banana), and (2) ethyl esters, the most abundant of which are linear chain ethyl esters that confer more complex floral and fruity characters. Differences in the release of these compounds can dramatically affect the flavor perceptions of beverages, including cider. Figure 3 shows the aromatic performance of all strains for all recipes.

We noticed significant differences between strains, and even when aromatic compound concentrations were affected by the recipe and, more specifically, the amount of sugars fermented (especially for isoamyl acetate whose acetate component is directly linked to the glycolysis pathway), we could observe common trends.

Except in the English cider, SafCider TF-6 always produced more isoamyl acetate than the other strains. For the English cider only, SafCider TF-6 was also able to dry out the sugars, which suggests a strong relationship between the stress generated at the end of the fermentation and the aroma produced.

SafCider AC-4 demonstrated particularly high but stable ethyl ester production, which was driven by ethyl octanoate (fruity/floral) and hypothesizes a reliable complexity in the flavors. SafCider AB-1 and SafCider AS-2 increased their ester production with the difficulty of fermentation, with SafCider AB-1 being on the low end.

FOCUS ON FRENCH TRADITIONAL SWEET CIDER

Relying on the expertise of IFPC and its trained taste panel, which specializes in French traditional sweet ciders, professional tastings were carried out on the French cider experiments, which ended with 30 g/L of residual sugar, called Brut cider in French.

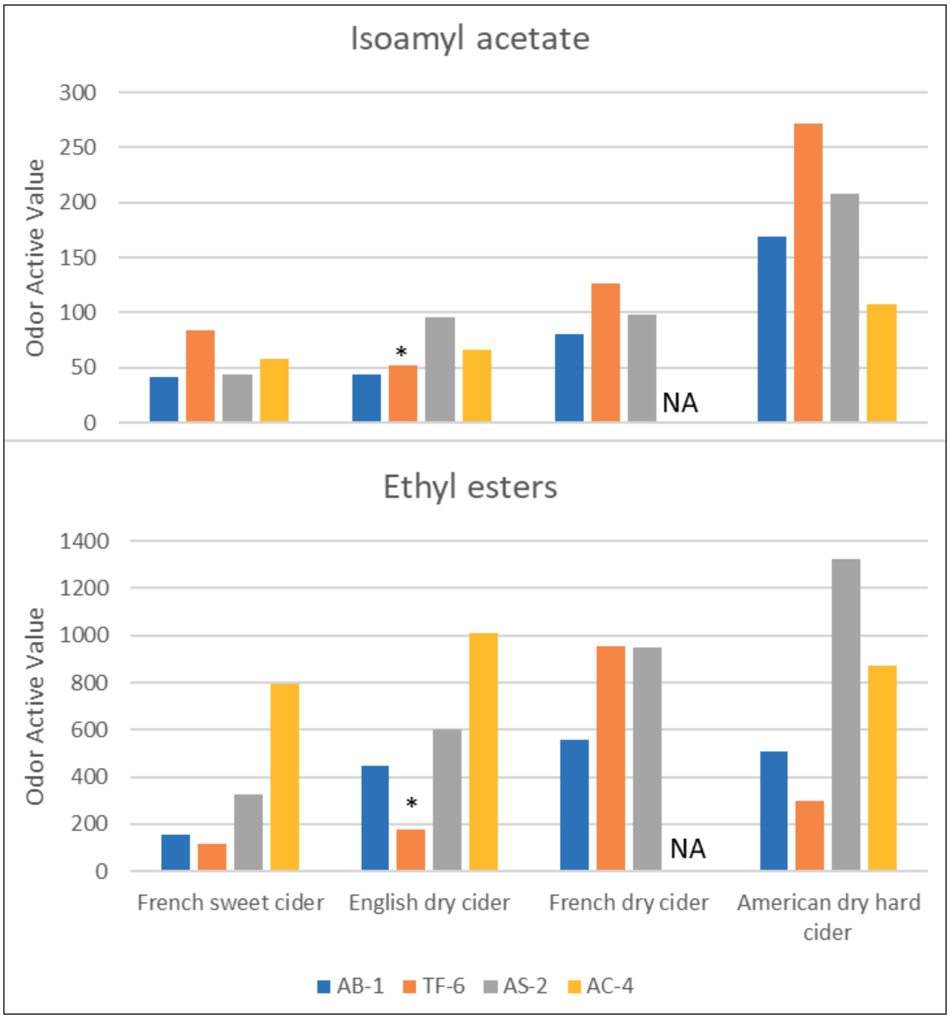
This tasting aimed to assess the fruitiness of the ciders with two major descriptors: (1) fruity/floral corresponding to fresh fruit perceptions (apple, pear, banana, etc.) and (2) cooked fruit representing ripe or processed fruits like compote. These are not necessary but can add complexity to the finished cider.

From these tastings, SafCider TF-6, in particular, and SafCider AS-2 were scored highest in fresh and cooked fruits, while SafCider AC-4 was judged to be less expressive and predominantly oriented towards freshness.

More interesting were the detailed fresh fruits perceived by tasters as shown in Figure 4. Obviously, sensory characterization of all ciders was driven by detection of apple notes, but SafCider TF-6 scored high for most of the fruits, especially banana-pear and red fruits. SafCider AS-2 and SafCider AC-4, respectively, exhibited more citrus and floral notes, whereas SafCider AB-1 was mainly centered on apple.

These notes correlate quite well with the production of aromatic compounds highlighted earlier. The higher production of isoamyl acetate by SafCider TF-6 offers more aromatic intensity and enhanced

FIGURE 3: CIDER STRAIN AROMATIC PROFILES



Strain aromatic profiles for all recipes with respect to isoamyl acetate and ethyl esters. *Odor active value* is defined as the concentration normalized by the perception threshold concentration. The asterisk indicates the sole recipe in which TF-6 was able to dry out the residual sugars. NA = data not available.

FIGURE 4: FRUITY-FLORAL DETAIL FOR FRENCH SWEET CIDER

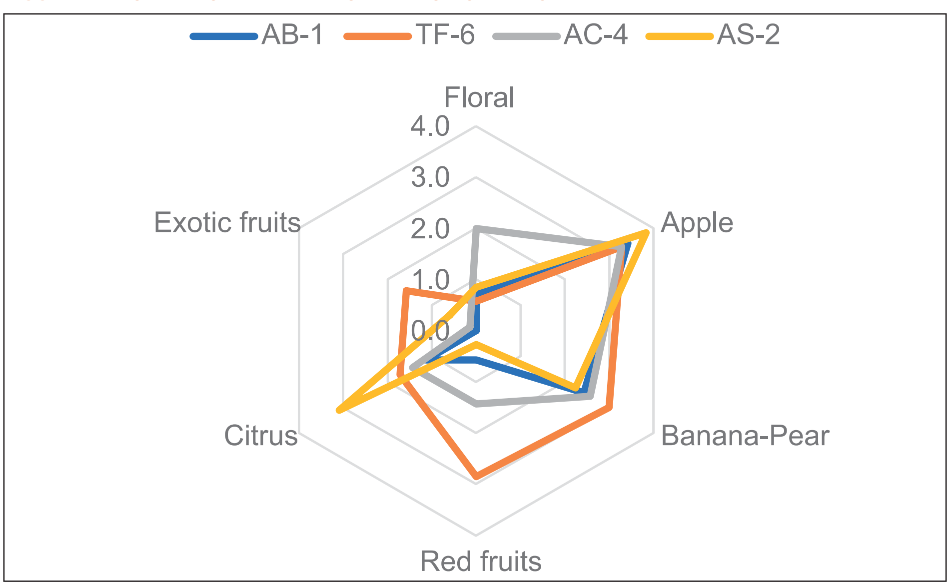
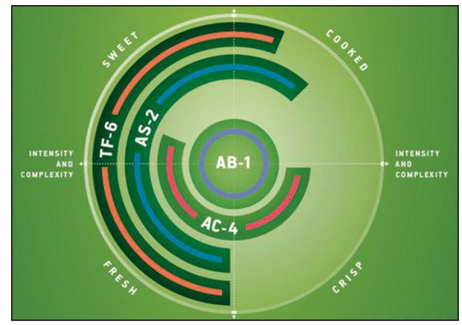


FIGURE 5: CIDER STRAIN BASELINES



Fermentis cider strains baseline map based on French sweet cider recipe.

aromatic complexity, followed by SafCider AS-2 and SafCider AC-4. The latter produces mainly ethyl esters such as ethyl octanoate, which could explain these red fruits and floral notes. SafCider AB-1 was the least exuberant and expressed more of the raw materials thanks to its subtle aroma production.

Combining the mouthfeel assessments (data not shown) that confirmed higher acidity perception for SafCider AC-4 and elevated sweetness perception for SafCider TF-6 and SafCider AS-2, Fermentis suggests the map in Figure 5 to describe the impact of these four yeast strains and to serve as a baseline for cidermakers in their choices.

YEAST SELECTION GUIDELINES

Yeast strain selection can dramatically affect a cider's profile, not just in terms of fermentation performances and analytics, but also with respect to sensory perception. Consequently, yeast can be considered a powerful tool to diversify the types of cider one produces.

SafCider AB-1 suits all types of balanced ciders, even under difficult fermentation conditions. SafCider AS-2 brings complex aromatic profiles of fresh and cooked fruits and a round mouthfeel to sweet and dry ciders alike. SafCider AC-4 works well for fresh, crisp sweet or dry ciders, while SafCider TF-6 is best suited to intensely fruity, but rather sweet and round cider.

Brew This!

PTQ Barbecue Rauchbier

Recipe courtesy of Peter Terzian, Brandon Bootleggers Homebrew Club.

A homebrew club in the next county to the north opened up its combination fundraiser and competition to other clubs in the area. One of our members had entered it last year and told us about it at a meeting. This year, three members of the Brandon Bootleggers Homebrew Club entered beers.

The competition is called the Iron Homebrewer, maybe because you need an iron gut to drink some of the concoctions that brewers come up with. Each entrant gets a randomly drawn unusual ingredient—I was assigned the best ingredient: barbecue sauce! What better base beer for this ingredient than rauchbier?

The challenge would be to develop a recipe with gentle smoke flavor and the right amount of sauce. My beer must have worked because I received many positive comments, such as "I could drink this all afternoon while I'm grilling" and "This is the best beer you've ever brewed!"

I only made 3 gallons because I didn't want to waste a lot of time and ingredients on a beer that I might have to throw out. Turns out I didn't make enough! We blew the keg before the event was over, and it was judged in the top 5 of 25 beers!

Batch volume: 3 US gal. (11.4 L)
Original gravity: 1.070 (17.1°P)
Final gravity: 1.025 (6.3°P)
Alcohol: 6% by volume

MALTS
3.3 lb. (1.5 kg) wheat liquid malt extract (1 can)
8 oz. (227 g) smoked malt
8 oz. (227 g) pale malt

HOPS
0.5 oz. (14 g) Willamette @ 60 min
0.5 oz. (14 g) Cluster @ 30 min

YEAST
Fermentis SafAle S-04

ADDITIONAL ITEMS
1 cup (237 mL) boiling water
½ cup (118 mL) Sonny's Original Barbecue Sauce

BREWING NOTES
Steep grains for 20 minutes in hot water. Add malt extract, bring to a boil, and add hops as indicated. Ferment to completion. At packaging, dissolve barbecue sauce in boiling water and add to keg or bottling bucket.

Brew This!

Fuller's Chiswick Bitter Clone

This was the AHA's 2008 Big Brew recipe, selected to honor English writer Michael Jackson, whom the worlds of beer, whiskey, and whisky had lost a few months earlier. Friend of the AHA and former AHA Governing Committee member Drew Beechum is credited with having obtained the recipe directly from John Keeling at Fuller's Griffin Brewery in Chiswick, West London.

An AHA member recently contacted us to ask for the recipe. We were so delighted to rediscover it that we decided to run it in this issue, as it had never before appeared in *Zymurgy*.

Batch volume: 5 US gal. (18.9 L)
Original gravity: 1.040 (10°P)
Final gravity: 1.010 (2.6°P)
Efficiency: 75%
Bitterness: 33 IBU

MALTS
7 lb. (3.2 kg) pale malt
5.6 oz. (160 g) crystal malt, 120°L

HOPS
0.5 oz. (14 g) UK Target, 11% a.a. @ 60 min
0.25 oz. (7 g) UK Northdown, 8.5% a.a. @ 15 min
0.25 oz. (7 g) UK Challenger, 7.5% a.a. @ 15 min
0.5 oz. (14 g) East Kent Golding, 4.75% a.a., dry hop in primary
0.5 oz. (14 g) East Kent Golding, 4.75% a.a., dry hop in secondary
0.5 oz. (14 g) East Kent Golding, 4.75% a.a., dry hop in keg/cask

ADDITIONAL ITEMS
¾ tsp. (3 g) Irish moss @ 15 min

YEAST
Wyeast 1968 London ESB Ale Yeast or White Labs WLP013 London Ale Yeast

WATER
If you want to emulate Fuller's water, aim for Ca 268 ppm, Mg 62 ppm, Na 30 ppm, SO_4 638 ppm, Cl 36 ppm, HCO_3 141 ppm.

BREWING NOTES
Mash grains at 149°F (65°C) for 60 minutes. Mash out at 160°F (71°C) and sparge with 170°F (76°C) water. Collect enough runoff to yield 5 gal. (18.9 L) after a 60-minute boil, approximately 6 gal. (22.7 L). Boil 60 minutes, adding hops and Irish moss as indicated.

Chill to 63–68°F (17–20°C), transfer to fermenter, pitch yeast, and aerate well. After 3 or 4 days, add the first dry-hop addition. Continue fermenting at 63°F (17°C) for a total of 7–10 days. Rack to secondary with the second dry-hop addition and age three weeks, at 50°F (10°C) if possible.

If kegging, rack to keg and add the third dry-hop addition to keg in a hop bag. If bottling, add the third dry-hop addition to secondary and then bottle normally. Carbonate to 1–1.5 vol. (2–3 g/L) of CO_2.

EXTRACT VERSION
Replace pale malt with 6 lb. (2.7 kg) pale liquid malt extract. Steep crystal malt in 2 qt. (1.9 L) of water at 150°F (66° C) for 30 minutes, raise temperature to 170° F (77° C), and then strain and sparge with 2 qt. (1.9 L) of hot water. Add an additional 1.5 gal. (5.7 L) of water, stir in extract, bring to a boil, and proceed with recipe as above.

No-Fee Homebrew Competitions

We know how excited AHA members are to get back into competition mode, and if the National Homebrew Competition was any indication, you brewed up some amazing beers during COVID-19 lockdown. With the country opening back up, it's time to stop sitting on your stash and get back to submitting. If you need encouragement, here are two competitions that have no entry fee—you need only submit your creations to compete.

And speaking of homebrew competitions, be sure to look out for our special coverage of the 2021 National Homebrew Competition in the upcoming Sept/Oct 2021 issue of *Zymurgy*.

HOLIDAILY BREWING GLUTEN-FREE HOMEBREW COMPETITION

Gluten-free beer has come a long way from those sorghum-syrup sorta-beers of old. Homebrewers are invited to submit their best gluten-free brews to Holidaily Brewing Co.'s third annual Gluten-Free Homebrew Competition. The top beer will be brewed at Holidaily, which will even send crowlers of their commercial version to the winning homebrewer.

Registration runs July 1–30, and there are zero entry fees, so get on it. For details, visit holidailybrewing.com.

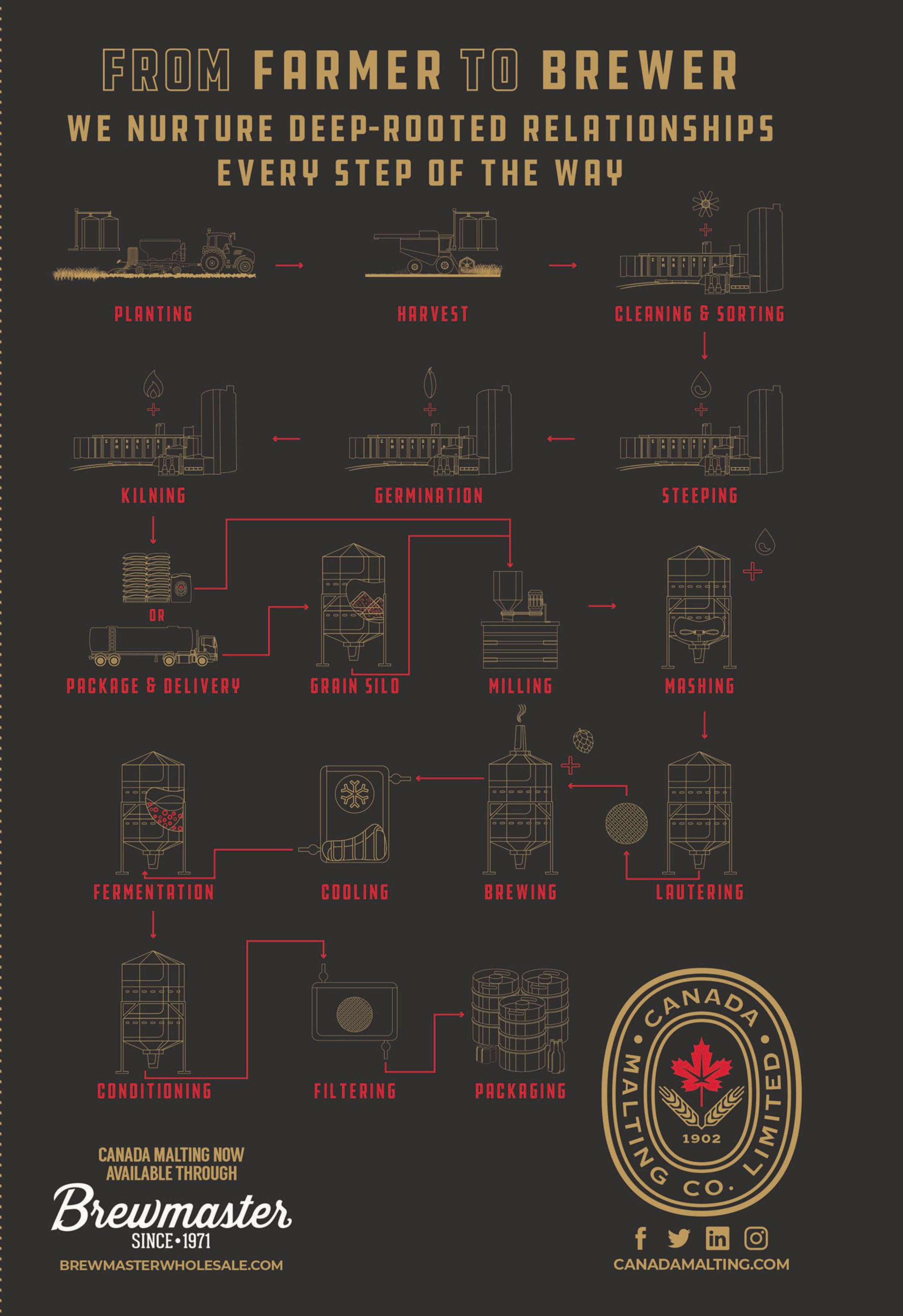
HOLIDAILY BREWING CO.

HOPPY POSSUM: SOUTHERN BREWERS CUP

The second annual Hoppy Possum: Southern Brewers Cup is taking place September 25 in Johnson City, Tenn. The event operates on a people's choice model in which festivalgoers vote on their favorite entries. Entrants compete for $10,000 in cash and prizes, and—did we mention this already?—there is no fee to enter the competition. Beer, cider, and mead are all welcome.

To learn more, go to hoppypossum.com.

HOPPYPOSSUM.COM HOPPY POSSUM: SOUTHERN BREWERS CUP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We Like Kveik

***Dear* Zymurgy,**
I thoroughly enjoyed your articles on kveik (Mar/Apr 2021). As an Aussie brewing without temperature control, kveik has been a godsend. Prior to its becoming readily available in our 2019–2020 summer, my brewing was restricted to six to eight months of the year. With my cellar's heat-wave ambient temperature of about 26°C (79°F), it was simply too warm to create quality pale ales.

No longer! I use the Lallemand Voss Kveik dry yeast and have fermented between 18°C and 29°C (64–84°F) with excellent results. It's so much more convenient being able to brew year-round.

There were some excellent tips in the articles, especially in Ryan Pachmayer's "Brewing Clean Beers with Kveik Yeast."

Cheers,
Peter Cotton
Brew-in-a-bag, no-chill brewer
Toowoomba, Qld., Australia

***Dear* Zymurgy,**
I enjoyed Ryan Pachmayer's article on kveik, especially the information about using these yeasts at less than 90°F (32°C). I wasn't able to locate that information on my own.

Cheers,
Steve Ruch
Crescent City, Calif.

PRIMED FOR SUCCESS

Dear* Zymurgy*,

I have a suggestion and request. I love the detail provided in recipes, especially water profiles, which I've noticed in a greater percentage in recent years. What I'd like, though, is carbonation by volume rather than sugar amounts for priming.

As you know, recipes rarely end up being exactly 5 gallons, and not everyone uses the same sugar sources. Additionally, lots of people keg, so a priming amount isn't very useful. So, listing the expected carbonation would be a lot more helpful than reverse engineering from the amount listed in cups. Kind of the same reasoning for providing an expected original gravity and not just malt amounts.

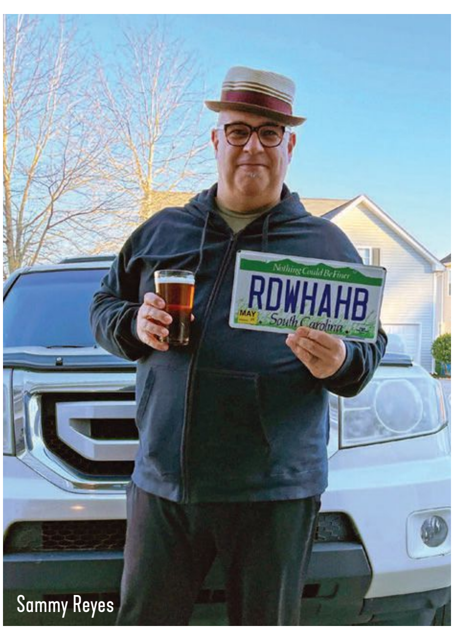
Thanks!
Cody Gabbard
Portland, Ore.

Zymurgy *editor-in-chief Dave Carpenter responds:* *Thanks for the suggestion, Cody. We're always looking for ways to make the recipes in* Zymurgy *as relevant as possible to a wide range of homebrewing approaches. We'll take your feedback into consideration as we continue to improve our recipe formulations.*

EXTRACURRICULAR ACTIVITIES

Dear* Zymurgy*,

I never thought that some notes on a napkin about what a homebrew club should be would turn into a club of more than 80 members four-and-a-half years later.



Sammy Reyes

I had an interest in starting a brew club local to my area, so I asked a brewing friend to meet me for a beer to talk about starting a homebrew club. We literally wrote down on a napkin some ideas about what we wanted in a club. We wanted to form a group whose members enjoyed making, tasting, and sharing beer, cider, and mead; a group focused on education and camaraderie; a group where we could learn how to brew better beer and learn about techniques and equipment.

In January 2016, Upper Palmetto Zymurgy Society (UPZS) held its first meeting. Since that initial meeting of about a dozen people, we have grown into a group of more than 100 and have officially become a non-profit 501(c)(7). As we continue to grow as a club, we are looking for ways to get involved in our community beyond the non-perishable food drives we currently do. We would also like to get more involved in the regional competition circuit. It's been fun watching the club grow with new brewers, experienced brewers, and everything in between.

A buddy of mine from the club, Mike Schenk, was highlighted in *Zymurgy* with his RDWHAHB license plate from North Carolina (Dear *Zymurgy*, Jan/Feb 2021). Well, he inspired me to do the same.

Cheers,
Sammy Reyes
Fort Mill, S.C.

Dear* Zymurgy*,

I have been an AHA member for close to two decades and I have enjoyed my membership immensely! I want to share my whimsical creation with the association. The pandemic, combined with chemo just before that, put me into a phantasmagorical mindset to create my own version of Brew Guru, a whimsical flight of fancy that visited me in a dream!

I fabricated my fellow by cutting the beer bottles with a stationary wet saw. His head is sourced from a collection of round glass blocks, and the various embellishments are made from copper, steel wool, and a couple of jars of marbles. The hands and feet are Champagne corks. It's all held together with wax.

>>

Cheerio!
Alan Mackenzie
Staten Island, N.Y.

BREW DOGS

What could be more fitting than Louis the English Setter looking after my bag of English Maris Otter floor-malted barley on brew day? Quality control was performed shortly thereafter!

Cheers,
Matt Weeks
Naperville, Ill.

Louis

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

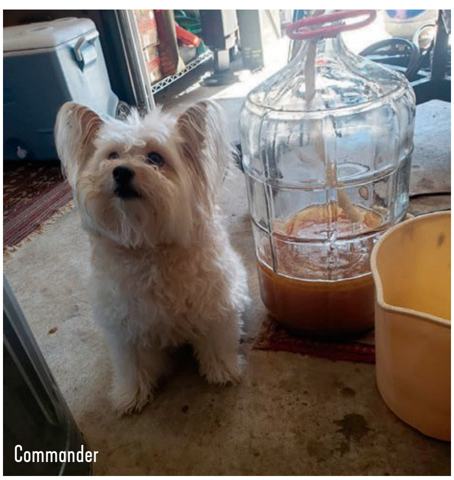
Photo © Getty/yuliash (carbonation)

Chip (big ears) and Dale helping out with a Bell's Two-Hearted clone. Probably looking forward to the spent grains at the end!

Mike Rose
Gilbert, Ariz.

Supervising brewing operations is Taz, my 15-year-old husky-shepherd mix. She chose to brew a California common for Big Brew day and is happily looking forward to spent-grain biscuits.

Cheers!
Rick Levinson
Eagle River, Alaska

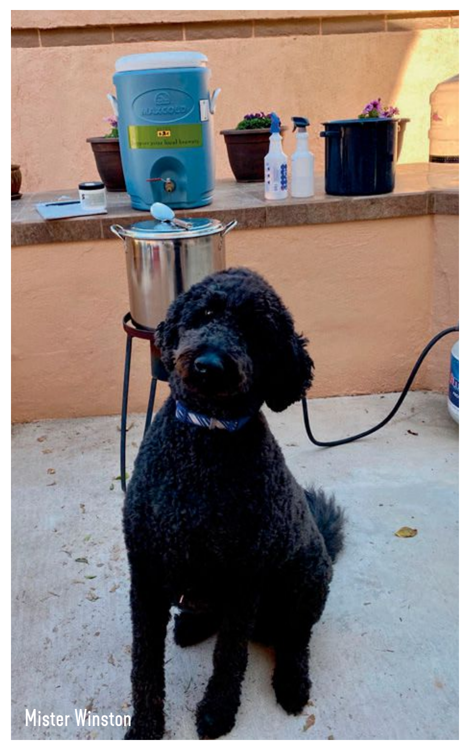


This is a photo of my brew dog, Commander. He's a Havanese Terrier who is nuts about beer and helps me brew sometimes. When I say, "brew dog," he starts running in circles and barking like a fool, waiting for his (very small) brew treat. He especially loves my Munich helles and Munich dunkel lagers.

Tim Hobbs
Chesapeake, Va.

Here's my buddy Maple helping me figure out how to brew a great IPA. We are both new on the job and very excited to be part of the homebrewing community.

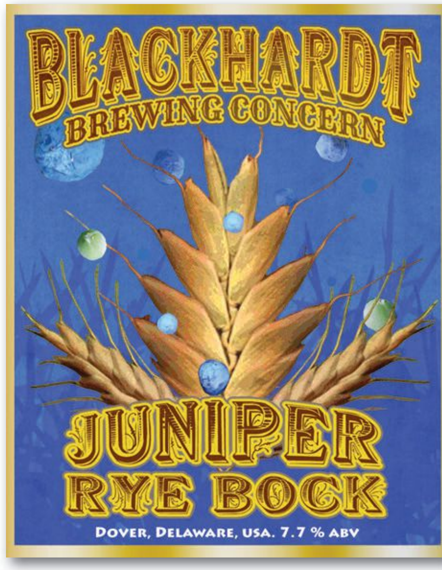
Cheers from the Pacific Northwest!
Joao Barbizam
Bellevue, Wash.



Here is my four-legged brewing assistant, Mister Winston, waiting patiently during the mash for a hoppy American pale ale. He never misses a brew session!

Kyle Mox
Phoenix, Ariz.

HOMEBREW LABEL SUBMISSIONS



I've been all-grain brewing about six years (158 brews) and have been an AHA member most of that time. My friend and colleague, art professor Josh Nobiling, designed two labels for me.

Both of the beers were for a "12 Beers of Christmas" exchange organized through HomebrewTalk. The Juniper Rye Bock was for this year's exchange and the Honey Ginger IPA was for last year's. We chose recipes from Randy Mosher's 12 Beers of Christmas found in his book *Radical Brewing*.

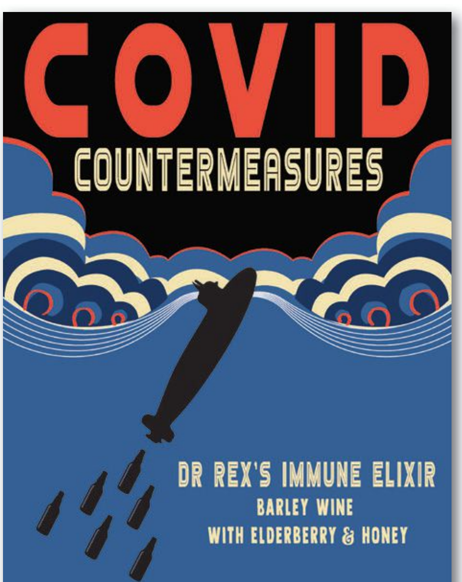
Jack Barnhardt
Dover, Del.

Artist Josh Nobiling adds context:
I had the honor of creating the Juniper Rye Bock label for Blackhardt Brewing Concern. I used Adobe Photoshop exclusively to create the label. Jack described the beer he was brewing and even provided me with some dry juniper berries and rye grains for inspiration, which, believe it or not, I ended up eating.

When conceptualizing any design, I always like to start by looking at nature. To quote Louis Comfort Tiffany, "Nature is always right. Nature is always beautiful." That was a good start.

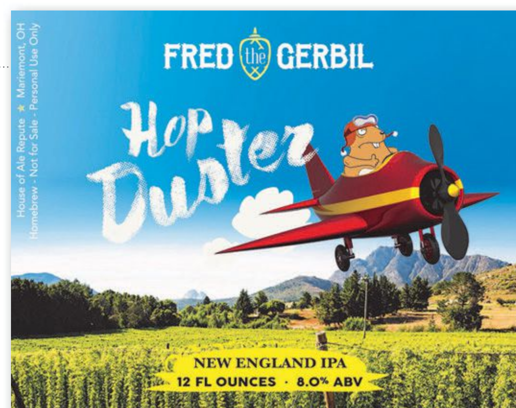
For this particular design, I wanted to use actual pictures of juniper berries and rye stalks to depict some sci-fi, extraplanetary situation. I used various size relationships and overlapping, as well as warm and cool colors, to create a sense of three-dimensional space in the image.

I should say that there was no real reason behind this particular theme, other than to satisfy my own childish imagination.



With COVID-19 plaguing our civilized world, I crafted an elixir to help protect my family and friends. My neighbor Maria Smith helped design the label.

Rex Morgan
Mt Pleasant, S.C.



The label is one in a series dedicated to my late friend and mentor, Professor Tim Keener of the University of Cincinnati College of Engineering. Tim shared with me the Legend of Fred the Gerbil. His freshman year roommate dropped out after one semester and left Tim with his pet gerbil, Fred. After all the cleaning and feeding and listening to that wheel spin, when Tim came home for the summer, he took Fred, his cage, and the accessories to the local pet shop and was able to get 10 dollars. With this, he purchased a case of Old German beer and had a blast that evening with his buddies, who all toasted, "To Fred!"

Matthew Ayer
Mariemont, Ohio

SUBMIT YOUR LABEL
Do you make custom labels for your homebrew?
Want it featured here in the pages of *Zymurgy* for all to see your work?
Send them to us at HomebrewersAssociation.org/magazines/submit-bottle-label and we will take it into consideration!

Ethiopian Injera

By Amahl Turczyn

Ethiopia has a wonderfully diverse culinary tradition, but the one food that's found at nearly every meal is a spongy, fermented flat-bread known as *injera*. What makes this sourdough bread so unique is how it is used: it acts as a plate, a utensil, and a food staple that perfectly matches the usually spicy cuisine of various Ethiopian stews and salads. Injera's porous texture absorbs juices well, making it the perfect alternative to forks and knives when sitting at a communal table with friends and family. It's also very easy to make at home, provided you have an active sourdough starter (though even that isn't strictly necessary) and access to flour made from an indigenous whole grain known as teff.

Teff grains are tiny, roughly the size of poppy seeds, and they vary in color from pale beige to dark brown. Teff has been grown and eaten in Ethiopia and Eritrea for hundreds, if not thousands of years, though North American companies now grow and process it as well. It's not difficult to find online, and its earthy, nutty flavor is great for other breads as well.

Generally, darker teff varieties have more flavor. Ethiopian restaurants typically use lighter teff grains, which are often blended with wheat flour to save money and produce a more elastic, pliable, easier-to-use injera. Assuming you can get dark teff, though, you can make the homespun, authentic, full-flavored bread that preserves the ancient tradition of injera. (Teff is also gluten-free,

Photo © Getty/RuslanDashinsky

so go 100 percent teff if you have celiac concerns.) Otherwise, a blend with wheat or barley flour will produce a more manageable injera. Regardless, you will start with a long fermentation to develop a nice tartness along with leavening.

You can start with whole-grain teff and grind it yourself, which means you'll have a fresher-tasting end product, but since most people don't have flour mills, we'll assume you'll be starting with the freshest teff flour you can find—I like Bob's Red Mill, but several other companies also sell the pre-ground flour. The ratio of flour to water is 2:3, and it's as simple as blending the two along with two tablespoons of your favorite sourdough starter (I've also used a bit of active-culture yogurt or kefir with success if I don't have a sourdough starter on hand).

Blend everything up in a large bowl, cover it loosely with plastic wrap so the ferment has access to air but airborne microbes and mold spores can't easily fall in and spoil things, and keep the bowl at room temperature for three to five days. As with other lactic-acid-bacteria ferments, the longer and warmer the ferment, the more acidity it will develop. The injera batter, which should be roughly as thick as crepe batter, will develop a nutty, earthy tartness, and you will note fizzy gas bubbles rising after a day or two of fermentation.

Alternatively, you can use a pinch of regular bread yeast if no lactic culture is available, but you won't get the authentic tartness.

On a whim, I added a quarter cup of spent grains from an all-grain wheat beer I'd homebrewed to a 5-cup batch of injera, just prior to fermentation, and was pleased with the resulting bread. The natural lactic acid bacteria in the spent grain really kickstarted the injera fermentation. Just know that adding too much spent grain will mean your injera won't be as elastic as it would otherwise, so if you do try this, it works best to use 1 cup wheat bread flour and 1 cup teff as your flour base (which you would then blend with 3 cups water and the quarter cup of spent grains).

When the ferment has progressed to your desired level of tartness, it's time to cook the bread. Traditionally this is done on a large, flat, stoneware plate called a mitad that's positioned over a wood-fired stove. A nonstick skillet works great, too, though. Pour a thin layer of batter into the pan over medium heat and allow it to form a thin circle that covers the bottom of the pan. Cook for several minutes until bubbles form, surface, and pop, and the bread begins to lose its wet appearance, the same approach used with pancakes. Flip the injera carefully and cook a few minutes more on the other side until dry and porous in appearance. Don't overcook; you want it to be tender and slightly spongy in texture. Remove the bread to a separate plate and repeat until you've used all the batter.

That's it! You can roll up the breads if you want; they should not be too sticky.

Ferment This!

Ethiopian Injera

Yield: About 12 large loaves

FERMENTABLES

1 cup (140 g) teff flour
1 cup (120 g) bread flour
¼ cup (60 mL) spent grains from brewing (optional)

YEAST

3 g instant dried yeast (optional)
2 Tbsp. (30 mL) sourdough starter

OTHER INGREDIENTS

3 cups (710 mL) filtered water
½ tsp. (3 g) salt (optional)

PROCEDURE

Whisk flours and water together in a bowl, along with starter, yeast, and spent grains, if using. Beat until smooth and all lumps are gone. Cover loosely with plastic wrap at allow to ferment 3 to 5 days, until batter begins to smell tart, nutty, and bready. (If any mold forms on the surface, discard batch and start over.)

Heat a nonstick skillet over medium heat. Pour about half a cup of batter in the pan and tilt until it covers the bottom. Cook over medium heat until bubbles rise and pop and the surface begins to dry. Flip the injera and cook a few minutes more until bread is spongy and elastic. Repeat with the rest of the dough.

Mixing teff flour, water, and starter.


Fermenting injera batter.


Pour enough batter to cover the bottom of the pan.


When dry, flip the injera once.


Injera made with spent grain.

Photos courtesy of Amahl Turczyn; © Getty/pr2is (finished injera)

> “I love the texture and color variety of these feasts, and I always break out a bottle of fermented hot sauce and a jar of preserved lemons.

When your Ethiopian stews and salads are ready (doro wot, a spicy chicken stew, is the country’s national dish; berbere is a fiery harissa-like spice blend; and recipes for various collard greens and tomato-and-lentil salads are easy to find online), unroll a large piece of injera and arrange your colorful array of delicacies in piles right on the bread. Then serve and enjoy with more rolls of the bread for each person to scoop bites into their (or their neighbor’s) mouths. I love the texture and color variety of these feasts, and I always break out a bottle of fermented hot sauce and a jar of preserved lemons; both are great garnishes for this type of cuisine. Enjoy!

Amahl Turczyn continues to brew and write at his home in Lafayette, Colo.

Ferment This!

Doro Wot

Spicy chicken stew with boiled eggs

Yield: Serves 4

INGREDIENTS

2 lb.	(1 kg) boneless skinless chicken thighs, cubed
2	large onions
1 cup	(250 mL) chicken stock, as needed for onions
½	lemon, juiced
½ cup	(250 mL) clarified butter (niter kibbeh or ghee)
1 head	fresh garlic (peeled and crushed)
¼ cup	(60 mL) grated fresh ginger
½ cup	(125 mL) berbere spice blend
6	boiled eggs, peeled
salt	to taste

PROCEDURE

Marinate the chicken in fresh lemon juice for 30 minutes. Grate the onion to a fine pulp with a cheese grater. Melt the clarified butter in a heavy pot, then add the onions and caramelize on low heat for an hour. Stir occasionally and add chicken stock if onion begins to darken too much. Add garlic, ginger, and berbere when onion has reached a deep golden brown color and simmer another 30 minutes. Add chicken, cover, and simmer 30 to 45 minutes, until chicken is thoroughly cooked. Add boiled eggs to stew and simmer another 10 minutes Adjust for salt and serve with fresh injera bread.

Ferment This!

Berbere

This spice blend is used widely in Ethiopian cuisine and is the basis for many traditional dishes.

Yield: about ½ cup (125 mL)

INGREDIENTS

½ tsp.	(3 mL) whole allspice berries
1 tsp.	(5 mL) whole black pepper
½ tsp.	(3 mL) whole fenugreek seeds
½ tsp.	(3 mL) whole cardamom seeds
1 tsp.	(5 mL) whole cumin seeds
1 Tbsp.	(15 mL) cayenne pepper powder (or to taste)
3 Tbsp.	(45 mL) paprika powder
1 Tbsp.	(15 mL) smoked paprika powder
1 tsp.	(5 mL) turmeric powder
1 tsp.	(5 mL) powdered ginger
1 tsp.	(5 mL) onion powder
1 tsp.	(5 mL) garlic powder

PROCEDURE

Toast whole spices lightly in a small cast iron skillet until fragrant. Pulverize to a fine powder in a spice grinder. Cool, blend with remaining powdered spices, and seal in an airtight container for later use.

PROSPERITY THROUGH CLARITY

A Guide To Beer Clarity and Brewing Bright Beer

By Jason Simmons

Before the "haze craze" of New England–style IPA (NEIPA), brewers usually strived to brew beers with respectable clarity. Today, beer clarity can range from the turbidity of Bavarian-style hefeweizen and NEIPA murkiness to brilliantly bright pale lagers.

Modern homebrewers have easy access to the same knowledge and ingredients, and many of the same types of equipment, as commercial brewers. By observing a few key considerations, home enthusiasts can create bright, brilliant, picture-perfect beers just like the pros.

MASH COMPOSITION

The old rule of thumb that water good enough to drink is water good enough for brewing applies in most cases. Take the time to understand your water report, even if only to know what you have to work with. For proper yeast health, adequate attenuation, and good fermentation performance, your water should have at least 50 parts per million (ppm) of calcium. This helps yeast ferment and flocculate as expected. If calcium levels are below 50 ppm, you can add brewing salts.

The composition of your brewing water likely changes throughout the year. Consequently, so do the brewing salts you need to add to achieve a given water profile. Depending on your desired chloride-to-sulfate ratio, increasing calcium levels will dictate which salts—such as calcium chloride ($CaCl_2$) or gypsum $CaSO_4$—to add. Your water report will also dictate whether you add salts to the mash to adjust pH or simply add them to the kettle for mineral content. The key to water and salts is to keep the calcium in the range of 50 to 150 ppm for good yeast health.

Photo © Getty/studiocasper

There are plenty of options for malt and grains on the market. In addition to the classic maltsters we already know and love, it seems like new craft maltsters pop up every day across the United States. It is common to hear that today's malts are so well modified that they readily convert starches to sugars. This may be mostly true, but there is more to malt than just diastatic power.

The biggest factor I have found is protein content, and most malts fall within a respectable range of protein content of about 9.5 to 12.5 percent. I have seen firsthand, though, the filtering issues of an 11 to 12 percent protein malt compared to a 9 to 10 percent protein malt. When my brewery tried a new malt supplier, we filtered batches side by side, and the difference was clear. This opened my eyes to the importance of malt selection.

Hefeweizen is made with wheat, roggenbier is made from rye, and New England IPAs frequently include oats in the grist. Malting these grains makes them more suitable for brewing, but unmalted wheat, rye, and oats are packed full of beta glucans, which are sticky polysaccharides that like to gum up your mash and create hazy beer. It's possible to brew bright beer using grains high in beta glucans, but one must pay extra attention in the mash.

TABLE 1: PROTEIN CONTENT OF SELECT BASE MALTS

Manufacturer	Product	Protein	Tolerance
Crisp	Maris Otter	9%	± 1%
Rahr	Standard 2-row	11.5%	± 0.5%
Rahr	Standard 6-row	12%	± 1.5%
Weyermann	Pilsner Malt	11%	± 0.5%
Weyermann	Munich Malt Type I	11%	± 1.5%

Data obtained from manufacturer websites.

MASH SCHEDULE

Many of us have experienced the frustration of a stuck runoff—a generous helping of rice hulls can aid lautering and prevent a stuck mash. Depending on the grains you use, adjusting the mash schedule can also improve runoff and clarity.

Amylase enzymes are responsible for converting starches into fermentable sugars that yeasts can consume. Good mash efficiency in terms of sugar extraction, however, doesn't necessarily mean that beta glucans and proteins have been sufficiently degraded. Additional mash rests can help when working with malts high in protein, under-modified malts, or malts high in beta glucans.

For grists high in beta glucans, a 20-minute beta glucanase rest at 100°F to 110°F (38–43°C) can improve lautering and yield clearer wort. John Palmer states in *How To Brew* that protein rest temperatures occur in the range of 113°F to 131°F (45–55°C). I like to aim for 122°F (50°C) to give myself a little temperature buffer and help ensure that I am in the right temperature range, but targeting the lower end of that range can encourage some beta glucanase activity, too. Depending on the degree of malt modification, protein content, and temperature, the protein rest can last 15 to 30 minutes.

After the protein rest, the mash temperature is raised to a saccharification temperature range of 145°F to 155°F

Lets Kick It Rauchbier

Photos courtesy of Jason Simmons

> "More time vorlaufing can mean less time waiting for the beer to clear.

(63–68°C). I personally like to target 150°F (66°C) when homebrewing.

German beers are known for their clarity (hefeweizen notwithstanding), and German brewers have historically conducted decoction mashes. A decoction mash is performed by removing a portion of the main mash to another kettle and slowly heating it to a boil. Sometimes a brief saccharification rest is included before boiling the decoction. The decoction is then boiled for 10 to 30 minutes, depending on how much melanoidin flavor, aroma, and color you want to create. The boiling decoction is returned to the main mash to raise its temperature to the next rest.

Decoction mashes can benefit brewers who have low-calcium water. Boiling malt precipitates calcium and magnesium phosphates, which may be at least partially responsible for a small reduction in mash pH. Some breweries have produced style-defining beers using very soft water and decoction mashes.

Vorlaufing (recirculating) the wort until it becomes bright is beneficial. As wort is passed through the mash bed, the spent grain filters out most particles and allows clean, stable wort to flow to the kettle for further protein breakdown. The less debris you transfer at each step, the less debris you have to worry about in the end product. On average, my homebrew vorlauf is usually 15 to 30 minutes, or until I am satisfied with its quality and clarity.

Does this really make a difference? Absolutely! I have seen the effects at a small scale in my homebrewing and on a large scale in the brewery, in side-by-side samples in which the only difference is vorlauf time. More time vorlaufing can mean less time spent on the cold side waiting for the beer to clear.

BOIL

There are several reasons to boil the wort, ranging from volume reduction and sugar concentration to isomerization of hops alpha acids, wort sanitization, and protein breakdown. The vigor of the boil influences how well proteins coagulate. Maintaining a full, vigorous, rolling boil encourages excellent hot break.

The classic homebrewing boil length is often 60 minutes. A 60-minute boil essentially maximizes hops bitterness extraction—more time yields only a few more IBUs. You can make excellent beer with a 60-minute boil, but I preach the 90-minute boil because you get a better hot break. Light-colored malts that are prone to dimethyl sulfide (DMS) also benefit from a 90-minute boil to better drive off that corny, cabbage-like compound.

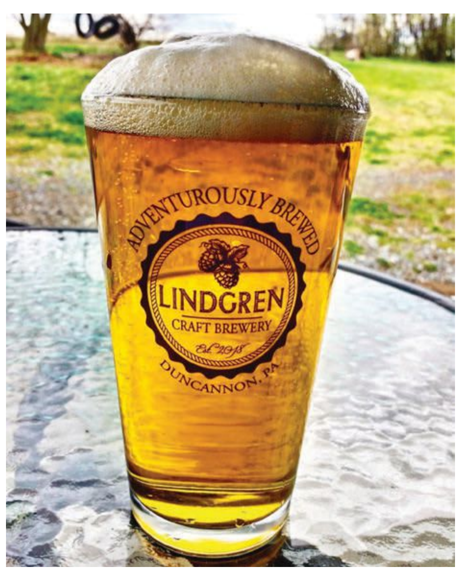
HOPS

Thanks to New England IPAs and their ridiculous late-boil and whirlpool hop dosing rates, we are now better aware of the polyphenols that contribute to the style's haziness, especially in large doses. If we don't want them in our beers, then keep the hopping rate down or pick a style that uses minimal hops. Alternatively, consider isomerized hop extract for bitterness. Cryo Hops from Yakima Chief Hops—alternatives to pellet and whole leaf hops—can cut down on vegetal matter and associated polyphenol content.

Whether you use hop bags or one of many stainless hops filters out there, the

Weak in the Knees.

Damn Your Dickens.



Lindgren Lager.

purpose is to contain the hops in an easily removable device. As in the vorlauf, you want to transfer the brightest wort possible to the next vessel. Such devices ensure that hop matter stays in the kettle and doesn't make its way to the fermenter.

I prefer muslin cheesecloth bags to the nylon ones. One batch of melted-nylon-bag pumpkin ale was enough for me to switch over forever. Also, I have come across a dough ball effect when packing the hop bags full of hops. This can lower hop utilization, doesn't achieve the target IBU, and is a waste of product and money. Keep an eye on this or use multiple bags.

OTHER KETTLE ADDITIONS

Irish moss or its refined form, Whirlfloc, is red algae that grows in rocky areas along the Atlantic coast and contains carrageenan, which is negatively charged. As wort cools during the cold break, the carrageenan structure shrinks and pulls protein particles together. This forms larger particles that more readily drop out of solution, creating a bright wort to transfer to the fermenter. An average dose is 20 to 30 ppm for a 5-gallon batch, or roughly 1 to 2.5 grams.

Including yeast nutrient in the boil adds vitamins, essential nitrogen compounds, carbohydrates, and minerals to the wort, which help give yeast the best possible chance for proper fermentation. A benefit of healthy yeast is proper flocculation, which means brighter beer in a shorter amount of time. The recommended dosage for yeast nutrients varies from one manufacturer to another, so be sure to follow their guidelines. On average, typical usage is 1 gram (or less) of nutrient per gallon of wort.

YEAST

Yeast selection depends on beer style, desired flavor, and performance characteristics. When it comes to clarity, it's vital to consider flocculation, a yeast's tendency to form clumps and drop out of suspension.

Some yeast strains, like White Labs WLP300 Hefeweizen Ale Yeast, are poor flocculators. Others, like White Labs WLP002 English Ale Yeast, flocculate very well. The higher the flocculation capability, the more quickly the beer will become bright after fermentation. This feature is often the reason breweries choose highly flocculent yeasts as house strains.

Proper dosing rates are imperative for healthy and complete fermentation. Overpitching adds more biomass than is necessary, and more effort is required to remove it. Not pitching enough cells leads to stressed yeast that may not achieve full attenuation. Always aim for a proper pitch rate, which is proportional to original gravity and inversely proportional to temperature—more cells are needed for a high-gravity lager than for a low-gravity ale.

FERMENTATION

As we mentioned, having proper yeast dose and ideal fermentation conditions will give your beer the best results all around. Healthy yeast performs and cleans up better than beat-up, lazy, or tired yeast.

Dry hopping a beer introduces vegetal matter and more polyphenols. The more that you use, the more work must be done to remove it. Can you have bright IPAs that use lots of dry hops? Absolutely, but it might take more finings, time at cold temperatures, or, in some extreme cases, even filtration.

After fermentation is complete, it is best to cold crash a beer by dropping the temperature to as low as you can without freezing it. To be safe, I always target 33°F (1°C). The colder the temperature, the more quickly any particles in the beer will settle out. The warmer the temperature, the longer you have to wait.

FININGS

Although some brewers continue to use isinglass (a type of gelatin made from the swim bladders of sturgeons), today's more common fermenter finings include Clarity Ferm, Biofine Clear, and gelatin.

White Labs Clarity Ferm

Clarity Ferm is an enzyme that breaks down proteins that can contribute to chill haze. Another great aspect of this product is its ability to reduce gluten concentrations to less than 20 ppm, which is the international threshold for a product to be labeled as gluten free. We use this at the brewery and like the results we have seen. There are different dosage rates depending on your recipe, so it is suggested to go to the White Labs website and use their online calculator. On average, a typical dose of Clarity Ferm for a 5-gallon batch is about 10 mL.

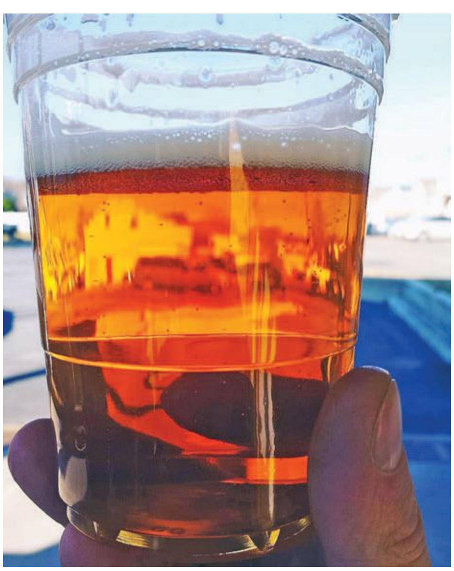
Biofine Clear

Biofine Clear is a game-changing product that I highly recommend to any brewer looking to produce bright beer. There's no filtering required, and it cuts down on the time spent at cold cellar temperatures waiting for the beer to brighten. At the brewery, we dose at a rate that brightens beer within two to four days of dosing, about 95 milliliters per barrel, which works out to 15 milliliters in a 5-gallon batch.

Gelatin

I have used gelatin in the past with great success. It's not popular among my vegetarian friends, but it is effective and easily found in just about any grocery store. I like the box of Knox Unflavored Gelatine that

Try It Before You Taste It.



Knox Gelatine.

includes four 7.6-gram envelopes, each of which is good for a 5-gallon batch.

I place about a cup of water (237 mL) into a coffee mug and heat it to 150°F (66°C) in the microwave, which is easy and fast. You don't want the water to be too hot because it gelatinizes like making Jell-O. Keeping it at 150°F (66°C) allows the pack of gelatin to mix into solution without gelling up. When you add that mixture to your beer when cold crashing, it easily mixes into the beer. Depending on all other variables, you can usually achieve bright beer within two to four days. The dosing rate is one pack (7.6 g) per 5-gallon batch.

MATURATION

The old-school method of clarifying beer without modern finings involves a cold temperature and plenty of time. The colder the beer can get without freezing, and the longer the beer sits at that temperature, the more handsomely, brilliantly bright the beer will be. All you need is time and cold. A general rule of thumb for lagering is roughly four to six weeks for beers of 13°P (1.053) and under, and up to 12 weeks or more for higher gravities.

FILTRATION

For some advanced brewers with kegs and CO_2, filtering can be an option. The two most common types of beer filters for homebrewers are cartridge and plate (plate-and-frame) filters. They have either a mesh/cloth cartridge or a plate that the beer passes though, leaving particles and sediment behind. The micron rating indicates the size of particles allowed to pass through the filter, and most homebrew filters range from 1.0 (fine) to 5.0 (coarse) microns. If you plan to filter down to 1.0 microns, it is recommended to first filter with a 3- to 5-micron filter to remove the bulk of the sediment so as not to clog the fine filter.

TRANSFERRING AND PACKAGING

When transferring beer off the yeast and into a bottling bucket or keg, do your best to minimize sediment transfer. Over the years, I notice a roughly 10 percent loss in volume in racking clear beer, so expect to leave the murky stuff behind.

When cleaning kegs, and especially bottles, be sure to look for any debris that might be left in the container. Properly cleaning and sanitizing equipment and following all product recommendations will help prevent contamination with wild yeast or bacteria in the bottle or keg, something that may cause haziness at least. At worst it will spoil your beer. Whether kegging or bottling, make sure that all of your gaskets, fittings, and crown caps are properly working and sealed.

Like most things in homebrewing, brewing clear beer isn't just achieved through a single process or piece of equipment. Instead, clear beer is the culmination of a series of small steps that add up to a noticeable difference.

Which will you choose to use to create your photo-worthy bright beer? You have the science; the art is up to you.

Jason Simmons has brewed professionally since 2003 and has worked for several breweries on the East Coast as brewing consultant, part-time beer author, and, currently, head brewer at Lindgren Craft Brewery in Duncannon, Pa. Hombrewing remains one of Jason's passions—he encourages homebrewers to never stop learning, sharing, and reaching for their goals.


PROG
62
75
CLEAR
HR
MIN
MEAT
TASTE
MODE
START
STOP
°F/°C/

OPTIMIZING MASH TEMPERATURE

BY CHRIS PINNOCK

Controlling temperature throughout the brewing process is one of many ways a homebrewer can make better beer. The mash is held at a suitable temperature, the grains are rinsed with hotter water, the wort is boiled, and fermentation is conducted at near room temperature for an ale, or colder for a lager.

To mash, we usually take crushed grain at room temperature and add it to suitably hot water in a mash tun. If you own a tun with heat control or a tun than can be heated, you can easily raise the temperature, provided you take care to avoid any unwanted caramelization. Many of us use insulated mash tuns or converted coolers with no way to easily heat them. In these cases, care is needed to hit the desired temperature.

Although the science applies to all mash protocols, let's initially limit ourselves to obtaining a good mash temperature for a single-infusion mash. We want to hit the sweet spot between 149°F and 155°F (64°C to 68°C) and keep the mash there whilst sugars are extracted. We may want to mash low in the range to get more fermentable sugars or high in the range to retain body and some sweetness.

The temperature of the hot liquor when it is put into the mash tun is called the *strike temperature*, and we are interested in calculating this value reliably. The strike temperature needs to be sufficiently high so that when the grain is mixed, the resulting mash temperature is within the target range.

→

In some homebrew books (such as Palmer's *How To Brew*[1]) you will find this formula for the strike temperature:

$$S = M + (0.2 / R) \times (M - G)$$

where

S is the strike temperature in degrees Fahrenheit.
M is the desired mash temperature in degrees Fahrenheit, e.g. 150°F.
G is the temperature of the grain in degrees Fahrenheit, usually room temperature.
R is the ratio of water to grain (the mash thickness), i.e. the volume of water in quarts divided by the weight of grain in pounds.

You may already use a rule of thumb for calculating strike water temperature, such as "8°F to 15°F higher than the mash temperature."

We can explain why this formula works using the conservation of energy law from science. We can also explain where the 0.2 comes from and why the rule of thumb above is more or less correct. To do this, we will need to use a bit of algebra. You may well have left science and algebra behind at school with some relief, but today you'll learn a practical application of both that you can use in your homebrewing.

METRIC VS IMPERIAL

On this side of the pond, in the UK, we measure temperature in degrees Celsius (°C). I'm old enough to remember the weather forecast being given in Fahrenheit here, but when I visit the USA, it still takes me time to adjust.

Scientists around the world use the standardized unit of Kelvin (K). The Kelvin scale measures temperature from absolute zero, Celsius is based on a scale in which 0°C is the freezing point of water and 100°C is the boiling point, while Fahrenheit is based on a scale in which 0°F is the freezing point of a certain brine and 90°F is a close estimate to the body temperature of a human (The estimate of 90°F was later shown to be too low.).[2]

Photos © Getty/da-kuk (mash temp); courtesy of Chris Pinnock

We can convert between them easily:

$$°C = (5/9) \times (°F - 32)$$

$$°C = K - 273$$

so that

0 K	=	–273°C	=	–459.4°F	(absolute zero*)
273 K	=	0°C	=	32°F	(freezing point of water)
373 K	=	100°C	=	212°F	(boiling point of water)

* Actually, absolute zero has been shown to be slightly lower, but this measurement is good enough for us.

Naïvely, one could plug in the conversion formula from Fahrenheit to Celsius to the mash formula and not see a difference. However, when we measure in metric units, we usually measure the weight of grain in kilograms and the volume of water in liters. Because 1 quart equals 1.137 liters and 1 pound is 0.454 kilograms, the ratio of grain in metric units is *roughly twice* that in imperial units:

$$L / kg = (qt. \times 1.137) \div (lb. \times 0.454) \approx 2 \times qt. / lb.$$

The strike temperature formula in metric is usually given as

$$S = M + [(0.41 / R) \times (M - G)]$$

where

S, *M*, *G* are temperatures as before but measured in degrees Celsius.
R is the ratio of water to grain (the mash thickness), i.e. the amount of water in liters divided by the amount of grain in kilograms

METRIC-IMPERIAL EQUIVALENCE

We can easily work through the conversion from metric to imperial. Remember that the temperature can easily be converted from Fahrenheit to Celsius:

$$°C = \frac{5}{9}(°F - 32)$$

And the mash ratio in metric is twice (when measuring in kilograms and liters) that of imperial (when measuring in pounds and quarts). So, if we have the measurements in imperial (Fahrenheit, quarts, and pounds) we can substitute them in the metric formula:

$$\frac{5 \times (S - 32)}{9} = \frac{5 \times (M - 32)}{9} + \frac{0.41}{R \times 2}\left(\frac{5 \times (M - 32)}{9} - \frac{5 \times (G - 32)}{9}\right)$$

which simplifies to:

$$S = M + \frac{0.41}{R \times 2}(M - G) \approx M + \frac{0.2}{R}(M - G)$$

For the purposes of what we are doing 0.41 ÷ 2 is close enough to 0.2.

You can derive the Fahrenheit version easily from this—we divide the number 0.41 in half because of the differences in the ratio for metric and imperial: 0.2 is a good enough estimate for us in the formula. See the sidebar on the facing page for details.

If we replace Celsius with Kelvin, we get the same formula, as we still measure grain and water in metric units. The reason I'm telling you all this is that it will be easier to explain the science in metric units. We will measure the temperature in Kelvins, weight in kilograms, and liquid volume in liters. Note that 1 liter of water weighs 1 kilogram, so we can use volume and weight for water interchangeably (Strictly, we should say mass instead of weight. Weight, measured in Newtons, is the gravitational force exerted on a mass measured in kilograms. Weight in Newtons is roughly 10 times the mass in kilograms.).

Energy

Our problem is really about heat energy. In metric, energy is measured in Joules (J); in the imperial system, energy is measured in calories. We are interested in the heat energy of our mash, namely the grain and water in their initial states and in their mixed state. In high-school physics we learn the conservation of energy law which states that *the total energy of an isolated system remains constant over time*.

If we can measure the energy of the grain and water before and after we mix them, the two values must be the same using this scientific law. There will obviously be some heat loss, but to make our model easy we will assume that it is negligible.

The heat energy of a substance can be found by multiplying these values:

1. Temperature of the substance in Kelvins (K).
2. Weight (mass) of the substance in kilograms (kg).
3. Specific heat capacity of the substance in Joules per kilogram per Kelvin [J/(K kg)].

Note the units of the values—multiplying them yields a value in Joules.

The *specific heat capacity* (SHC) of a substance is the amount of heat energy needed to increase the temperature of 1 kg of the substance by 1 Kelvin.[3] For example, the amount of heat energy required to raise the temperature of 1 kg (1 L) of water by 1 K is 4179.6 J, so the SHC of water is 4179.6 J/(K kg).

Not surprisingly, the SHCs of many substances have been measured and recorded. The values can vary depending on the temperature of the substance. We are only interested in the SHC of malt barley and water—it turns out that the SHC of malt barley (assuming certain water content and other conditions) is approximately 0.41 times that of water. You will find slightly different estimates if you look this value up, but it is good enough for our purposes.

My favorite reference for this value is in an old paper, "On the Specific Heat of Malt, and the Calculation of the 'Initial Heat' of the Mash," which was discussed at a meeting in the London Criterion restaurant in January 1910.[3] The thought of 18 gentlemen sat around a table in morning dress, discussing mashing, no doubt whilst consuming a bottle of port, is comforting. The paper describes the strike formula, and British thermal units per degree Fahrenheit per pound, BTU/(°F lb.) are used to describe SHC.

The paper specifies 0.41 BTU/(°F lb.) as the SHC of malt barley containing approximately 3.4 percent moisture. BTUs were designed so that 1 BTU/(°F lb.) is the SHC of water, which is enough for us to conclude that the specific heat of malt is 0.41 times that of water.

We have now reviewed enough science to estimate the strike formula.

Strike Formula

We are going to compute the energy of the mash in its individual components and then the energy after they have been mixed. The conservation of energy law says that these values must be the same. We need to set up some variables before we start. We want to compute *S*, the strike temperature. This is the temperature of the brewing liquor that we add to the mash tun. Here are the other variables we will need.

M is the desired mash temperature, usually around 66°C.
G is the grain temperature, usually room temperature, 20–22°C.
V_G is the weight of the grain in kilograms.
V_W is the volume of the strike water in liters.

We also need the specific heats of our two key ingredients:
H_W is the specific heat of water.
H_G is the specific heat of grain, which is $0.41 \times H_W$.

Let's consider our components as we put them into the mash tun and calculate the energy of each component using the three images below.

Our grain has specific heat H_G, weighs V_G, and has temperature G.

Our strike water has specific heat H_W, weighs V_W, and has temperature S.

The total energy of the water and grain mixed at strike time is the sum of the two.

$$H_G \times V_G \times G \quad + \quad H_W \times V_W \times S \quad = \quad H_G \times V_G \times G + H_W \times V_W \times S$$

We want the mash to settle at temperature M. The heat energy of the grain needs to be

$$H_G \times V_G \times M$$

and that of the water needs to be

$$H_W \times V_W \times M$$

so that the desired total energy is

$$H_G \times V_G \times M + H_W \times V_W \times M$$

The conservation of energy law says that the total energy of this closed system remains constant. Ignoring negligible heat loss, the energy before the strike water and grain are mixed is the same as the energy after, so

$$H_G \times V_G \times G + H_W \times V_W \times S = H_G \times V_G \times M + H_W \times V_W \times M$$

Your high-school algebra nightmares start here. However, we are interested in a formula in terms of S, so all we need to do is subtract $H_G \times V_G \times G$ from both sides and then divide by $H_W \times V_W$:

$$S = [(H_G / H_W) \times (V_G / V_W) \times (M - G)] + M$$

This looks more like the formula we saw in the introduction. We defined R to be the mash ratio, the volume of water divided by the weight of grain, V_W / V_G, and we know that $H_G = 0.41 \times H_W$, so the formula is

$$S = 0.41 \times [(M - G) / R] + M$$

IN PRACTICE

We have not considered the properties of the mash tun in any of the estimates above. Provided you get your mash tun sufficiently hot before mashing in, the heat loss will be negligible. I usually warm up my mash tun by putting in boiling water and leaving it for 10 minutes before draining and mashing in. I put the hot liquor into the tun at a slightly higher temperature than needed, and when the temperature approaches the desired strike temperature, I start to add the grain.

Remember the 8–15°F rule of thumb we mentioned earlier? The rule of thumb really depends on the mash ratio. If we assume that our grain is at room temperature, 68°F, and that the target mash temperature is 151°F, our formula gives us the range 8–15°F depending on the mash ratio:

MASH RATIO 2 QT./LB.	MASH RATIO 1 QT./LB.
$S = 0.2 \times \frac{(151 - 68)}{2} + 151 \approx 159.3$ °F	$S = 0.2 \times \frac{(151 - 68)}{1} + 151 \approx 167.6$ °F
8°F higher than the desired mash temperature	15°F higher than the desired mash temperature

If you use the same mash thickness every time you brew and you want to achieve the same target mash temperature, you can get away with using the same rule of thumb for the strike water. If you brew different styles requiring a special mash temperature or brew in an environment with extreme temperature swings, it's prudent to use the strike formula.

Raising the mash temperature

The same principles can be used when adding hot water to the mash to raise its temperature. We might do this to step mash or if we have missed our target mash temperature. How much water should we add, and what should its temperature be?

Let's break the problem down into the variables:

M is the current mash temperature (e.g. 66°C).
T is the new target temperature (e.g. 72°C).
X is the amount of water added.
Y is the temperature of the water added.
V_G and V_W are the weights of the grain and water, respectively.
H_W and H_G are the specific heats of the water and grain, respectively.

Again, we use the conservation of energy law. We have two unknowns here—X and Y—but let's rearrange the formula for Y, the temperature of the added water.

Our mash is at temperature M.

We add X liters of water at temperature Y. S.

We want the new temperature to be T.

$$H_G \times V_G \times M + H_W \times V_W \times M \quad + \quad H_W \times X \times Y \quad = \quad (H_G \times V_G + H_W \times V_W + H_W \times X) \times T$$

$$Y = (0.41V_G + V_W) \times [(T - M) / X] + T$$

Now we can choose the volume of the water we want to add, X, and determine Y. It's no surprise that the imperial version of this formula is:

$$Y = (0.2V_G + V_W) \times [(T - M) / X] + T$$

Let's do some worked examples, one in Fahrenheit and one in Celsius.

1. **Adjusting mash temperature**
   Suppose I have 9 lb. of grain and 9 qt. of water. I've mashed in, but my mash is at 150°F. I want it to be at 152°F. I'm going to add 1 qt. of water. So,

   $$V_G = 9,\ V_W = 9,\ M = 150,\ T = 152,\ X = 1$$

   According to the formula, I should add 1 qt. of water at

   $$(0.2 \times 9 + 9) \times [(152 - 150) / 1] + 150 = 171.6°F$$

   If I added 2 quarts of water instead, the required temperature would be less:

   $$(0.2 \times 9 + 9) \times [(152 - 150) / 2] + 150 = 160.8°F$$

2. **Step mashing**
   Suppose I have 3 kg malt and 6 L water mashing at 66°C and I want to raise this to 72°C by adding water. The formula would be:

   $$Y = (0.41 \times 3 + 6) \times (6 / X) + 72$$

Here are some possibilities:

X (VOLUME)	Y (TEMPERATURE)
1 L	115.4˚C (not feasible, above boiling point)
2 L	93.7˚C
3 L	86.5˚C
4 L	82.9˚C

I could add 2 liters of water at 93.7°C or 3 liters of water at a more manageable 86.5°C. Of course, given that we are mashing in homebrew equipment, it may not be practical to add large volumes of water, and you might not want to dilute your mash very much. It might be wise to start with a thicker mash to compensate.

Incidentally, the same formula works to lower the temperature of the mash. Suppose I've mashed in with 3 kg malt and 6 L water, and my mash is at 69°C and I want to lower it to 67°C. The same formula gives me the temperature of the water I need to add to reduce the temperature of the mash. Let's assume I want to add 1 liter of water—the formula says that this water should be at 52.5°C.

$$Y = (0.41 \times 3 + 6) \times (-2 / 1) + 67 = 52.5°C$$

CONCLUSIONS

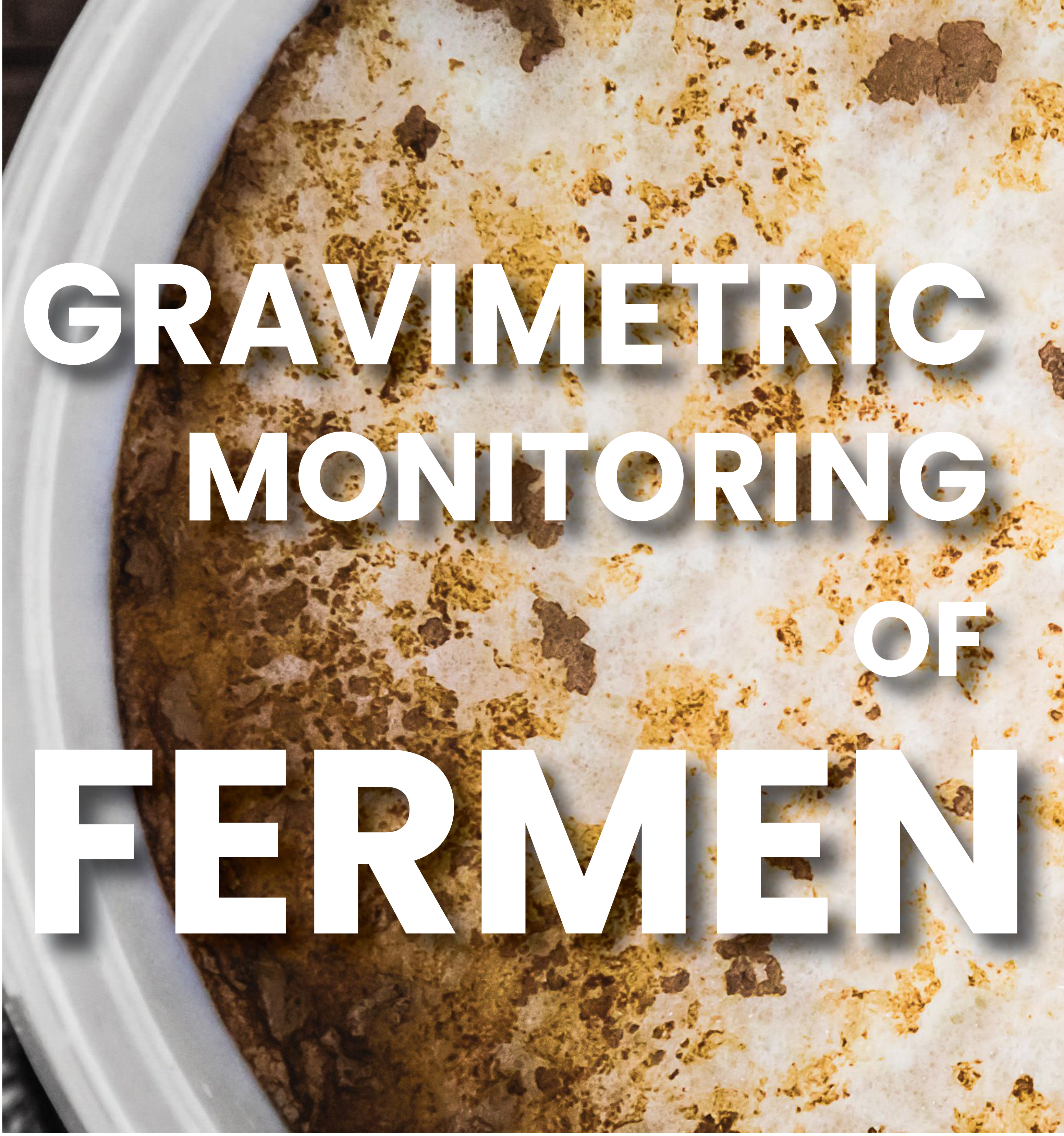
We've explained the strike formula using principles of high-school science. You can use the strike formula to estimate the hot liquor temperature and hit the right mash temperature every time you brew. If you ensure that your mash tun is hot before you mash and use the formula to estimate the temperature of the strike water, you will get better extraction results. Similarly, you can adjust the temperature of the mash by adding hot water and you can estimate the temperature with the formulas above.

THE CONSERVATION OF ENERGY LAW STATES THAT THE TOTAL ENERGY OF AN ISOLATED SYSTEM REMAINS CONSTANT OVER TIME.

RESOURCES

1. J. Palmer, *How to Brew: Everything You Need to Know to Brew Great Beer Every Time*, Brewers Publications (US), 2017.
2. Wikipedia, "Fahrenheit," Wikipedia, [Online]. Available: https://en.wikipedia.org/wiki/Fahrenheit. [Accessed 14 March 2021].
3. L. F. Horace T. Brown, "On the Specific Heat of Malt, and the Calculation of the 'Initial Heat' of the Mash.," 1910. [Online]. Available: https://onlinelibrary.wiley.com/doi/pdf/10.1002/j.2050-0416.1910.tb04689.x.

Chris Pinnock is an IT consultant and trainer who has been brewing beer at home for five years. He has won various awards at competitions and is interested in the science behind brewing. When he is brewing, you will find him with a thermometer, hydrometer, and pH strips, measuring everything.



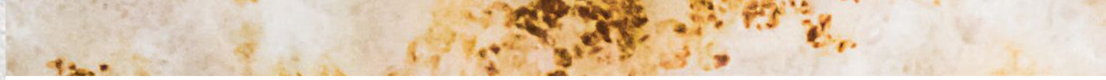
GRAVIMETRIC MONITORING OF FERMEN

TATION

By Andy Tipler

Brewers monitor fermentation progress to confirm that the transformation of wort into beer proceeds as expected, to indicate when changes are needed, and (most importantly) to alert the brewer that fermentation has finished. For the commercial brewer, such matters are important to brand quality, consistency, and profitability. Homebrewers have similar needs, but the most important aspect is to not waste time when the beer is ready.

What options do we have to monitor an active fermentation? There are generally two approaches: we can monitor the depletion of sugars or we can monitor the accumulation of ethyl alcohol, or some combination of the two. We can try to determine the concentration of either directly or use some technique that indirectly indicates their concentrations.



The direct determination of sugar or alcohol concentration usually requires chemical analysis using instrumental techniques such as high-performance liquid chromatography (HPLC) or gas chromatography (GC), respectively. While many commercial brewery laboratories will invest in such equipment, the cost is out of reach for most homebrewers. A fancy new red sports car will be cheaper to buy and run.

Fortunately, two affordable indirect solutions are available to homebrewers: the hydrometer, which measures specific gravity, and the refractometer, which measures refractive index. Both are good for taking measurements at the beginning and end of fermentation to indicate currently available sugars and estimated alcohol produced. However, it's not so practical for these instruments to provide continuous measurements during fermentation, as both normally involve manually opening the fermenter and taking a sample. Many of us like to sleep at night.

For continuous (and autonomous) monitoring of fermentation, some other technique is needed. One way of doing this is to somehow automate the hydrometer reading, and some companies offer products that do just that.[1,2] Some other companies count the bubbles eluting from an airlock.[3, 4] Another possible solution, and the one taken here, is to monitor the weight of the fermenter and use the power of science to turn these readings into meaningful results indicating the concentration of alcohol in the beer at any point during the fermentation.

This idea is not new, and there's an interesting article in doing just this.[5] However, there's more to getting the right answer than just taking the weight of a fermenter. Here, we'll consider the theory behind such an approach and discuss the difficulties involved in taking accurate weight measurements over a long period of time. We'll also discuss how a novel, self-made weighing scale using a wheelbarrow wheel and a breast pump can make this possible.

THE THEORY BEHIND USING WEIGHT

As all brewers know, the purpose of fermentation is to get those friendly little yeast cells to convert sugars into alcohol and hopefully also leave a pleasant taste in the beer. This process is actually quite complex, and numerous papers, articles, and books have been published on the subject. For our purposes, we just need to consider the relationship between the amount of sugar present at the start of fermentation and the amount of alcohol produced at the end.

Fortunately, this relationship has been well established. In 1843, Professor Carel Josef Napoleon Balling[6] of Prague Technical University put together his famous Balling equation[7, 8] based on his observation that

$$\begin{gathered}2.0665\text{ g extract in wort} \rightarrow \\ 0.9565\text{ g } CO_2 + 1.0\text{ g ethyl alcohol} \\ + 0.11\text{ g yeast dry material}\end{gathered}$$

The value 0.9565 for carbon dioxide is derived from the relative molecular weights of carbon dioxide and ethyl alcohol, which are 44 and 46, respectively. Fresh wort contains a variety of different sugars: monosaccharides like glucose and fructose, disaccharides like maltose and sucrose, trisaccharides like maltotriose, and unfermentable polysaccharides (or dextrins).

After mashing, larger sugars must be broken down by enzymes, expressed by yeast, into simple sugars before they can be absorbed into yeast cells and converted into alcohol and carbon dioxide. It doesn't matter what the sugar type is; the end result will still be the same—for each gram of alcohol produced, there will be a corresponding production of 0.9565 grams of carbon dioxide.

This means that if we can determine the amount of carbon dioxide produced during fermentation, we can determine the amount of alcohol produced. Under normal fermentation conditions, carbon dioxide will be a gas and there will be a lot of it. This gas will normally exit the fermenter through a suitable airlock, and this loss in gas will cause a significant loss in weight from the fermenter. So, in theory, if we can monitor this loss in weight, we can monitor the gain in weight of alcohol in the beer. This relationship can be expressed as follows:

$$ABW\% = 100 \times (W_s - W_f) \div (0.9565 \times W_f)$$

$$ABV\% = (ABW\% \times D_{beer}) \div D_{alc}$$

Combining these gives

$$ABV\% = [132.5\text{ mL/g} \times (W_s - W_f)] \div V_f$$

where

W_s is the starting weight of the unfermented wort.
W_f is the final weight of the fermented beer.
V_f is the final volume of the fermented beer ($W_f \div FG$).
0.9565 is the aforementioned Balling factor.
D_{beer} is the density of the fermented beer in g/mL.
D_{alc} is the density of ethyl alcohol, 0.789 g/mL.

For example, let's say that we have made a beer with a final volume of 20 liters (20,000 mL), and 1,000 g of carbon dioxide was lost during fermentation. Then the amount of alcohol could be calculated as

$$ABV\% = (132.5 \text{ mL/g} \times 1{,}000 \text{ g}) \div 20{,}000 \text{ mL} = 6.63\%$$

This calculation can also be performed during fermentation: we just need to know the starting weight, the current weight, and the volume of the beer. In practice, the volume of the beer changes negligibly during fermentation. Yes, some mass is lost, but the specific gravity decreases almost proportionally, so taking a volume reading at the start or end of fermentation is normally good enough.

Before moving on from the theory, we should consider a few important factors that can lead to errors in these calculations.

Not all carbon dioxide is expelled. Some of it remains dissolved in the beer even at the end of fermentation. Figure 1 shows the amount of carbon dioxide that remains dissolved in beer at different fermentation temperatures. For the example of 20 liters of beer, the plot would indicate that the weight of carbon dioxide left in the beer would be 20 L × 1.75 g/L = 35 g at 20°C. Out of the 1,000 g generated in total, this would represent a –3.5 percent error in the calculated weight of carbon dioxide generated.

Loss of water vapor. Expelled carbon dioxide gas will also be saturated with water vapor, which reduces the weight as shown in Figure 2. In our example, the total weight of water vapor lost with the carbon dioxide would be (recalling that the molecular weight of CO_2 is 44 g/mol and that 1 mol of any gas at occupies 22.4 L at 20°C and 1 atm)

$$(1000 \text{ g} \div 44 \text{ g/mol}) \times 22.4 \text{ L/mol} \times 0.018 \text{ g/L} = 9 \text{ g}$$

This would offset the error caused by the dissolved carbon dioxide, so now our total error will be 35 g – 9 g = 26 g or a –2.6% error.

FIGURE 2: Water Vapor Concentration in Escaping CO_2

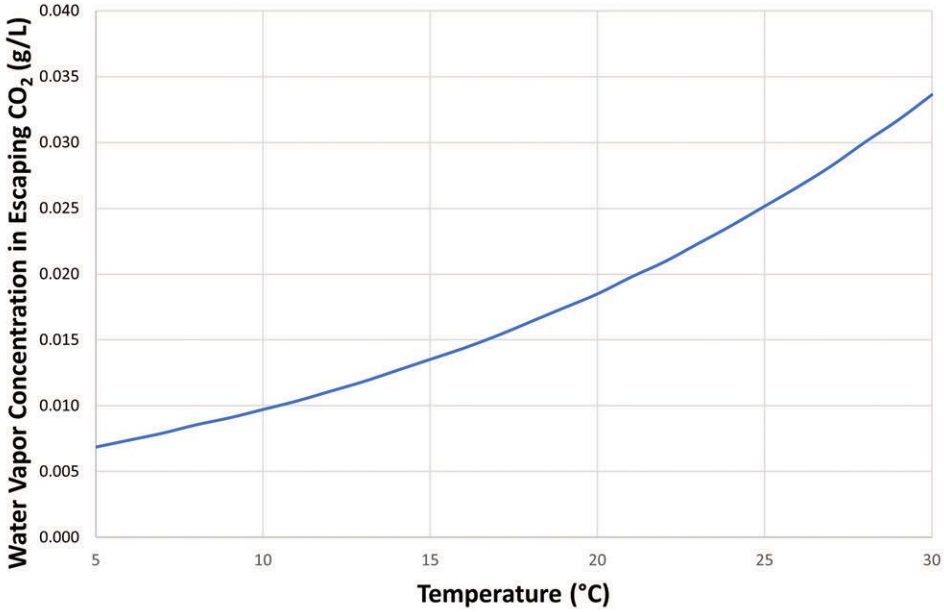
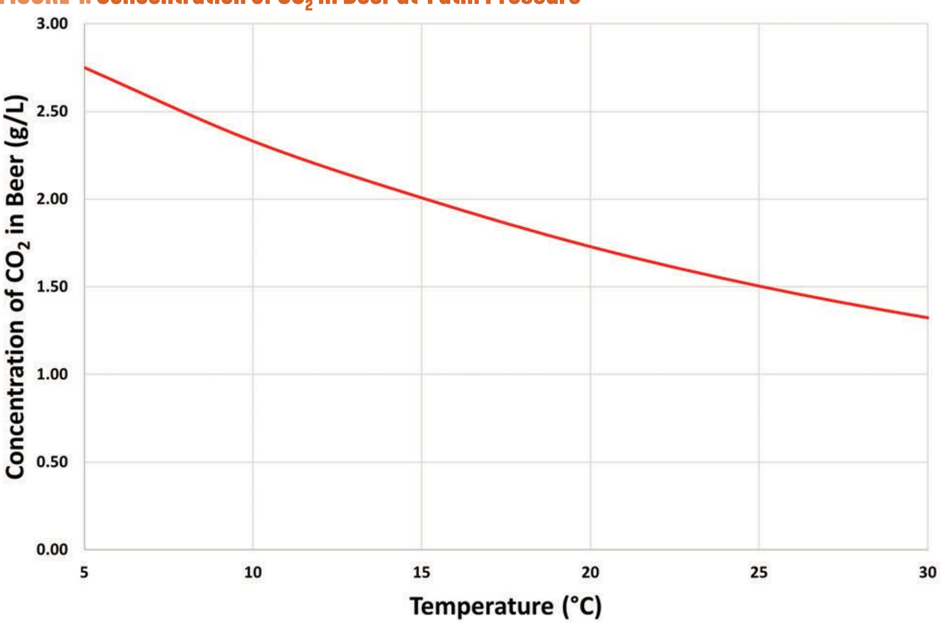


FIGURE 1: Concentration of CO_2 in Beer at 1 atm Pressure



As a side note, this explains why an airlock never dries up until fermentation has finished. During fermentation, the escaping gas is already saturated with water, so water in the airlock has nowhere to go. Once the gas flow stops, drier air from outside can enter the airlock and the water in it can evaporate.

Loss of alcohol vapor. Some of the alcohol in the fermenting beer will also pass into the escaping carbon dioxide gas, which reduces the weight and the amount of alcohol left in the beer. This calculation is quite complex and depends on the amount of alcohol in the beer. In practice, very little of the alcohol passes from the beer into the carbon dioxide, so this effect can be regarded as negligible.

The small errors in the ABV calculations from dissolved carbon dioxide and loss of water vapor can be incorporated into the calculations using Henry's Law equations.[9]

PROBLEMS IN MEASURING WEIGHT CONTINUOUSLY

Now that we know how to calculate ABV by weighing a fermenter, how do we take these weight measurements?

What weights and differences in weights are we talking about? In the previous example, we saw a 1,000 g change in weight for 20 liters of 6.63% ABV beer. For reference, this weight of carbon dioxide will occupy a volume of about 509 liters as gas. This is why you should never ferment beer in a fully sealed container.

That defines a typical total change in weight we need to measure when fermentation is complete, but what about the measurements during fermentation? Let's try to emulate a hydrometer that can measure specific gravity to a precision of 0.001. This change in gravity would represent a change in the beer of about 0.131% ABV or 0.104% ABW. Phrased another way, this represents a 20.8 g production of alcohol or a 19.8 g loss in weight of carbon dioxide in a 20-liter batch.

Thus, to make measurements equivalent to a hydrometer, we need a weighing scale capable of measuring a total weight change of up to 1,500 g to 2,000 g (for strong beers) with a precision of about 20 g for a full fermenter weighing about 25 kg (to support 6 gal. or 23 L). And it should be cheap! How possible is this?

I tried weighing an active fermentation on a regular postal scale, and I was surprised to see how good the results were. The particular model of weighing scale I used, which is available under various different brands for about $30, is shown in Figure 3. The vendor claims that it would be able to weigh up to 50 kg with a precision of 2 g, and it certainly seemed able to deliver this performance.

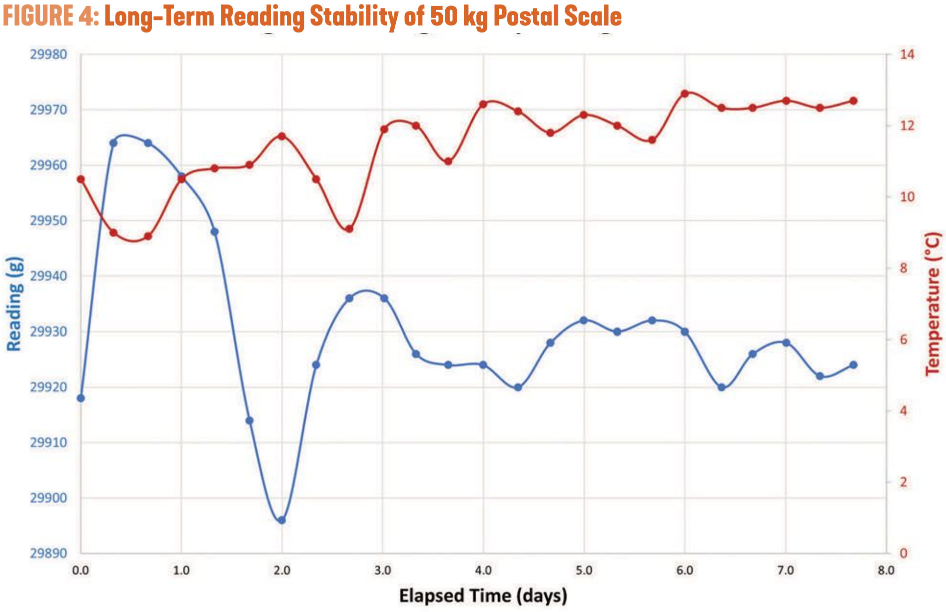
FIGURE 3: Postal Scale

Using such a scale, it's possible to calculate the alcohol content of finished beer as described earlier. However, when trying to continually monitor the weight of the fermenter, I found an issue that I suspect any other similarly priced scale will also have: the measurements are unstable. This well-documented instability is the result of physical distortion of the internal load cell used to make the measurements under heavy load. This effect is called *creep*, while environmental effects such as temperature changes on the whole system cause *drift*.

Figure 4 shows the weight displayed of a 23-liter (6-gallon) glass carboy full of water left on this scale for just over a week. This scale, when powered by an external adapter, provided a continual display of what it thought the weight was. Readings were taken manually (using pencil and paper) at approximately 8-hour intervals. As can be seen from this plot, the displayed weight varied significantly, particularly at the beginning when creep is at its worst. The temperature of the weighing scale is also shown in the plot, and there is a negative correlation with the results indicating the degree of drift in this device. We want to measure the fermenter weight to a precision of 20 g, and this was actually achieved after about three days. However, I don't think this can be relied upon.

To correctly use a weighing scale for heavy items means that first, a zero reading must be taken (taring). Next, the item to be weighed must be placed on the scale, a reading quickly taken, and then the item removed to allow the scale to recover for the next item to be weighed. Most scales shut down within a minute or two after taking a reading, so the operator doesn't notice creep and drift. This is particularly important for bathroom scales, as people might otherwise see their weight increase over a short period of time.

FIGURE 4: Long-Term Reading Stability of 50 kg Postal Scale



A NOVEL WEIGHING SCALE FOR CONTINUOUS OPERATION

So, to facilitate continuous monitoring of weight, the scale must be first tared before each reading and the item must be removed from the scale in between readings for a period long enough to allow the scale to recover before the next reading. Technically, we should not be calling these continuous readings but, rather, periodic readings. How can we do this automatically and autonomously?

My initial thoughts were to build some sort of robot, not unlike those we see in the movies, to lift the fermenter onto the scale, take a reading and then lift it off again—"Your weight data is ready, captain!" This was not feasible to build at home, so I had to use much more normal technology like a wheelbarrow wheel and a breast pump.

OK, I don't use the whole wheelbarrow wheel, but rather just the inner tube. If we place a heavy object on a deflated inner tube and then inflate it, it's surprising how much weight we can lift. Using a breast pump rated to about 6 psi to inflate the inner tube, we can lift an object weighing up to 50 kg by about 10 mm (enough for our purposes here) in just 30 seconds with a pressure of just 2 psi!

Lifting an active fermentation vessel is a piece of cake. The problem here is that we don't want to keep lifting the fermenter just between readings, as that would put a strain on the pump and other components in a possible design. The solution is to put the inner tube under the weighing scale so that the scale is lifted and pushed up against the fermenter positioned above it. Figure 5 illustrates the principle.

I could have used the same weighing scale that I showed earlier, but I not only wanted to take weight readings but also schedule them and process the measurement data to provide a direct indication of how much alcohol had been produced at any given time during the fermentation. So, I built my own weighing scale and ESP32 microcontroller for it. It's beyond the scope of a homebrewing magazine to go into all the technical details of this development, so I'll just show a few photos of the key components used in the construction. I plan to (eventually) post construction details for this on my website.[10]

FIGURE 5: Schematic Diagram of Self-Taring Weighing Scale

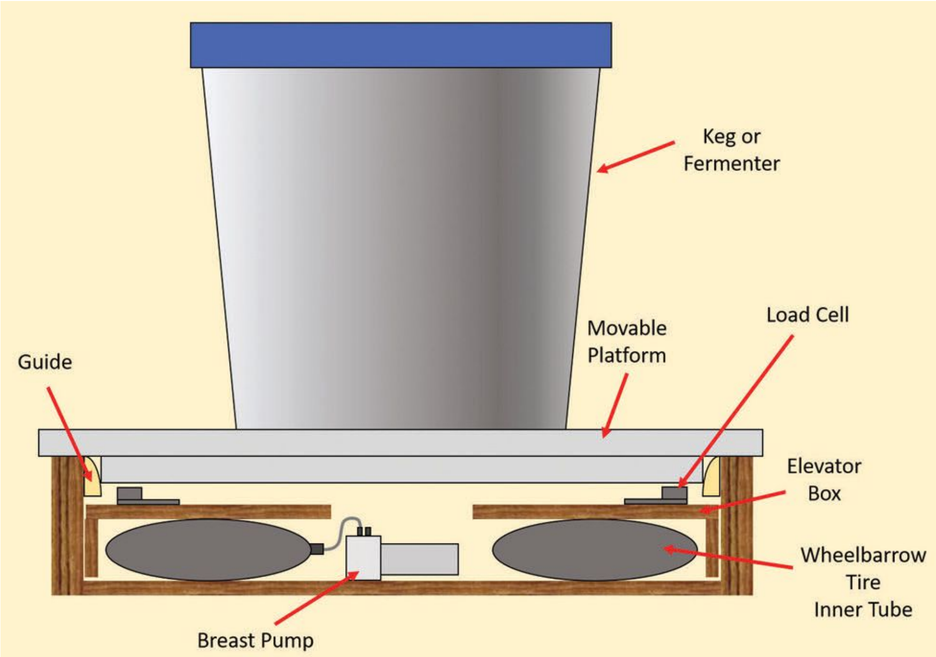


FIGURE 6: Positions of Load Cells and Temperature Control System

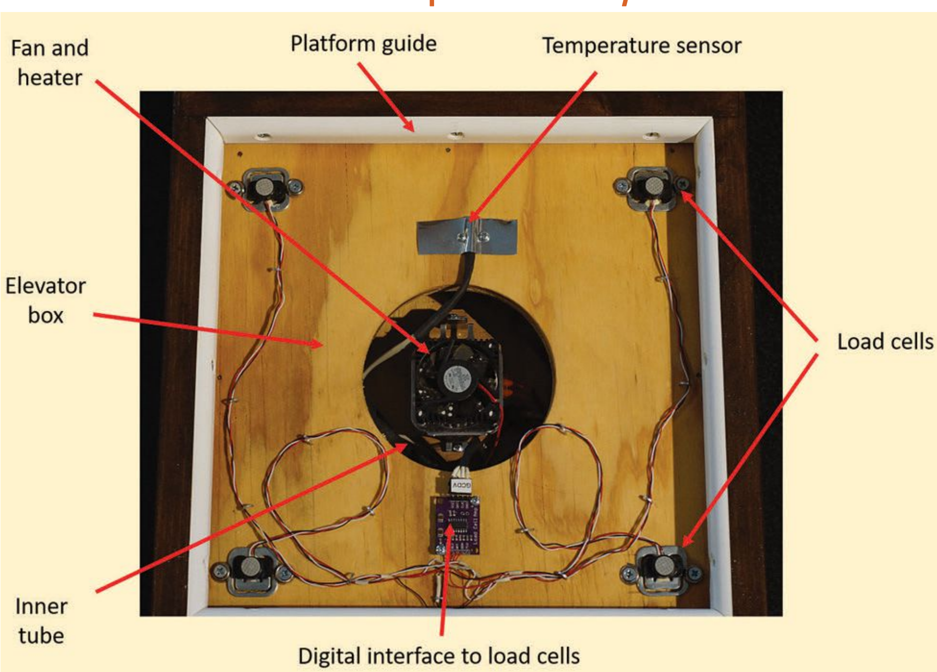


FIGURE 7: Prototype Weighing Scale

FIGURE 8a: Auto-Tared Weighings Linearity

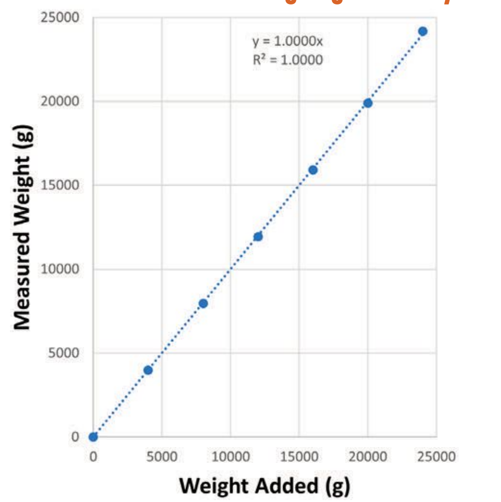


FIGURE 8b: Auto-Tared Weighings Linearity

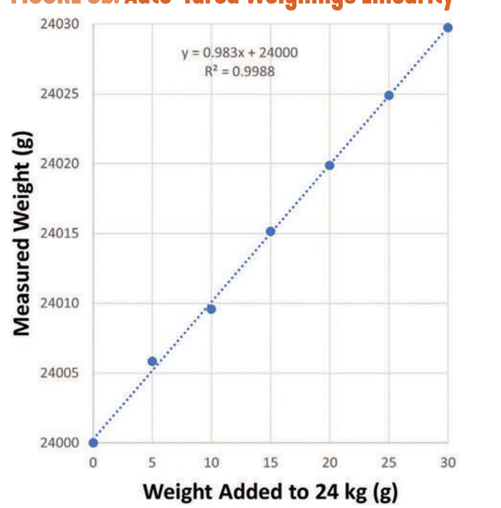


Figure 6 shows four half-bridge load cells, which take the weight measurements, mounted on a wooden elevator box. The inner tube sits below the elevator box and, when inflated, pushes the elevator box up so that the load cells push against the movable platform on which the fermenter stands. A small heater and fan are located at the center to thermostat the load cells and minimize thermal drift. Figure 6 shows the assembled scale actively lifting a fermentation bucket in order to take a weight reading.

Figure 8 shows the measured linearity of this weighing scale. Good linearity is important to achieve accurate results for the alcohol calculations. Not only is it important to get good performance across the whole weighing range as seen in Figure 8a, but it's even more important to be able to measure subtle changes in weight of a full fermenter as shown in Figure 8b. We need a precision of 20 g for our readings, and Figure 8b indicates that we can achieve this easily.

These data show that this weighing scale is quite capable of delivering the performance we need to monitor carbon dioxide and alcohol production. But how well does the auto-taring technology work? Figure 4 shows the effects of drift and creep on the stability of weight measurements. Figure 9 shows how much more stable the readings are for a constant weight when we tare the weighing scale prior to each reading, minimize the time the weight resides on the scale, and control the temperature to a fraction of a degree Celsius. In this plot, the standard deviation of the weight reading was 1.55 g, or 0.0079% on a weight of almost 20 kg over 12 days—not bad for a homemade device!

SOME EXAMPLE DATA

The functions for calculating ABV are built into the software controlling this weighing scale so that we can see the alcohol content develop throughout the fermentation. This process is fully automatic. Figure 10 shows an example of the weighing scale display indicating the ABV determined from the last weight measurement.

FIGURE 10: Displayed Measurements

Figure 11 shows the ABV values reported by the auto-taring weighing scale during the fermentation of an English barleywine over 30 days. Some extra dried malt extract was added after about 5 days, so the weight and volume of the beer were adjusted in the weighing scale at this point.

The final ABV was reported to be 10.77% which is very close to the 10.89% calculated from hydrometer specific gravity measurements. The big difference is, of course, that the interim ABV was being reported by the weighing scale, so a much more detailed picture of the fermentation profile was provided.

CONCLUSION

Although this project is still a work in progress, it does demonstrate a feasible and easy way of monitoring the progress of a fermentation by automatically taking weight readings throughout that fermentation. This is difficult to achieve using a regular weighing scale because of the creep and drift experienced over the fermentation periods in the load cells. A novel weighing scale has been developed to overcome these issues to provide stable weight readings over a prolonged period of time.

Although well suited to monitoring homebrew fermentations, I'm sure such a scale could be used for many other applications that require weight monitoring over long periods. Anybody keep bees?

FIGURE 9: Weight Reading Stability with Auto-Taring

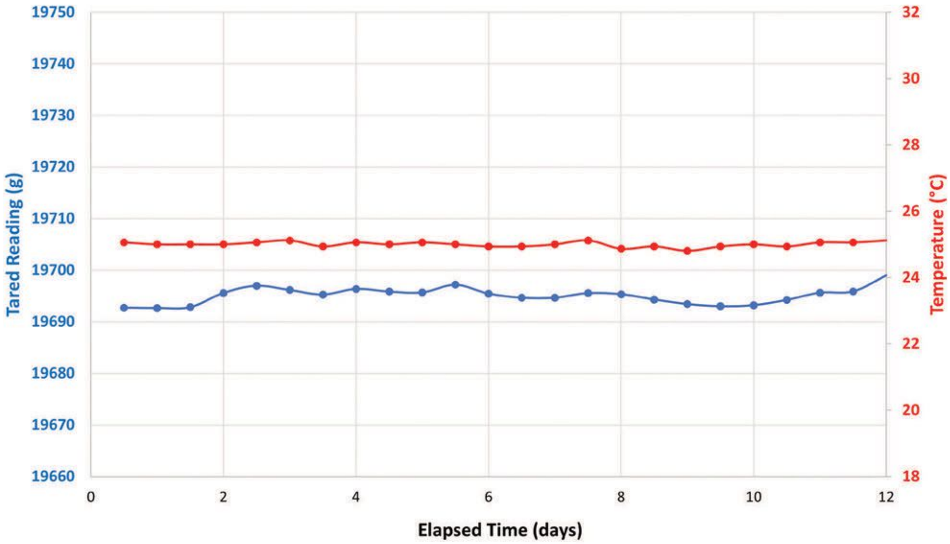
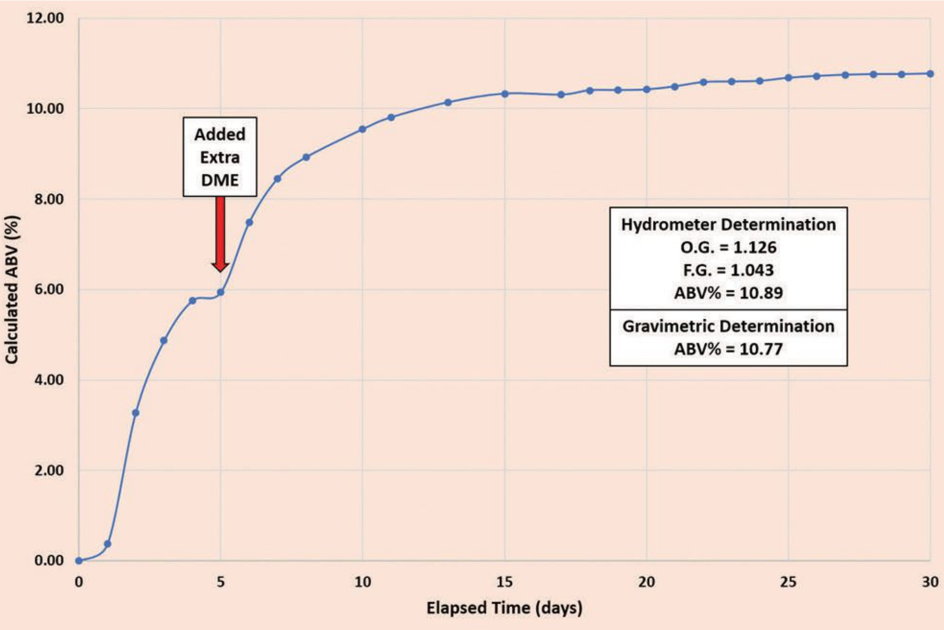


FIGURE 11: Fermentation of English Barleywine



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Andy Tipler grew up in England and moved to the United States 27 years ago for his job as a research chemist. He has been homebrewing (legally) for more than 50 years and is a certified beer, mead, and cider judge. Andy is active in competitions as a judge and as a contestant, and he enjoys talking and writing about brewing. He is a member of the Underground Brewers of Connecticut (the second oldest homebrew club in the USA). He would very much like to have an English pub next door.


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__Editor's Note:__ The editors of Zymurgy wish to thank Todd Bellomy of Farthest Star Sake for his technical guidance and feedback. Readers are encouraged to visit BostonSake.com to go even further down the sake rabbit hole.

MOLDED & POLISHED

Sake Making for Homebrewers

By Amahl Turczyn

Making sake at home is no more difficult a process than brewing an all-grain batch of beer, but it's not something you can knock out in a day—from start to finish it's about a five-week process. Most of that time, however, the work required is very easy: giving something a stir, checking a temperature, measuring out and soaking an ingredient, or, in the latter stages, simply waiting for fermentation to do its thing. Each step needs to happen in the correct order, though, so careful planning is required. If you are handy with scheduling, you can simply write out the whole process on your favorite calendar, set reminders for yourself so you don't skip a step, and then just follow along.

In the early stages, you'll build up a starter called *shubo*, or the seed mash. Once the starter has had a chance to establish a sufficient yeast cell count (usually over about a week at a controlled temperature), you'll move on the main stages of the process, which is where the real work starts. You'll add the starter, followed by progressively larger additions of the three primary ingredients, to your fermenter, where starch conversion and fermentation take place simultaneously. The process may seem complex, and it is admittedly lengthy, but taking it one step at a time will reward the patient homebrewer with excellent homemade sake. →

INGREDIENTS

We'll look at process specifics later, but first, let's examine the ingredients needed to make sake at home.

Water

Water for sake can be built by adding salts to distilled or reverse-osmosis (RO) water, much as you'd do for beer, but treated water is only needed for the initial yeast starter, and even then it's optional. Once koji begins to dissolve rice (more on that soon), vitamins and minerals are released into the fermenting sake, which are more than enough for yeast health. Any chlorine-free water is suitable for the main fermentation

Key components for the yeast starter's water include those found in ordinary wine yeast nutrient, but others are a little more difficult to track down. Magnesium sulfate is rarely used in brewing beer, but it's easy to find as Epsom salts and only a pinch is needed. Potassium chloride is an ingredient in Morton brand salt substitute, and again, very little is required.

Yeast

Speaking of yeast, one of the most commonly used sake yeasts in the world is widely available from yeast labs that cater to brewers. It's called Sake #9 yeast, but yeast labs have their own internal designations for the strain. Wyeast, for example, calls it Wyeast 4134.

Note that you'll provide the fermentables for the starter to get this yeast going, but you can't use malt extract! Instead, you'll feed your sake yeast steamed rice, water, and koji.

Koji

What is koji? It's steamed rice that has been covered with mold spores. Not very appealing by the sound of it, but this is a special type of mold—*Aspergillus orzyae*—that contributes the enzymes necessary to convert starch into sugar. Rice doesn't have the same naturally occurring amylase found in barley malt. That's where koji comes in.

The mold is first grown on cooked, sake-quality rice in a warm, humid environment. There are several kinds of koji, some of which are intended for fermenting miso, so make sure you get the right kind (for more on making miso, see You Can Ferment That!, *Zymurgy*, Mar/Apr 2021).

One of the best sources for koji specific to sake brewing in this country is SakeOne in Forest Grove, Ore. Their koji is grown on rice in-house and then dried and packaged in convenient 40-ounce bags. A great source for purchasing this SakeOne koji is F.H. Steinbart in Portland, Ore., which offers online sales. You *could* purchase koji spores, steam the rice yourself, and grow your own koji rice sufficient for a batch of sake, but this requires a special setup to maintain a warm, humid environment, and the process is complex enough to merit its own article.

When the inoculated koji rice is mixed with water; steamed, cooled rice; and yeast, the mold creates sugar from starches in the rice at the same time that yeast ferments those sugars into alcohol. This "parallel fermentation" allows the yeast to metabolize sugars and produce alcohol gradually, which in turn allows it to tolerate much higher alcohol concentrations than it normally would. Depending upon a few factors, sake fermentations can be as high as 22% ABV. Most sake is then diluted to 13% to 15%, but you will have the option to bottle it full-strength—this is called *genshu* sake.

Rice

One of the factors that determines sake's strength is the degree of polish on the rice used. Polishing rice before it is steamed results in cleaner, smoother sake because the kernel of each grain of rice is made up of purer starch. However, sake made from highly polished rice is lower in alcohol; usually a maximum of 18 percent ABV at full strength. Rice used by

Photos © Getty/Kayocci (brush characters); Getty/kf4851 (sand ripple); Getty/AlasdairJames (rice); Getty/kazoka30 (sake); courtesy of Amahl Turczyn the big sake breweries is always polished, sometimes down to 50 percent of the original husked rice kernel.

Obviously, a rice polisher a specialized piece of equipment, and they are not cheap! Table rice you can buy at the store, by comparison, is rarely polished more than 10 percent. Because of the "impurities" in this form of rice, things like protein and fat in the starch surrounding the core of the kernel, fermentation proceeds further, allowing for higher alcohol production, but the resulting sake has a harsher taste. It's a bit like trub in the brewing world; a little will help your yeast, but too much will degrade the quality of the finished product.

Rice grown and polished specifically for making sake is difficult to find outside Japan, but there are some sources. The degree of polish determines the grade of finished sake. Rice polished down to 70 percent of the original grain makes *junmai*; down to 60 percent makes *ginjo*; and down to 50 percent produces the very finest, smoothest sake, *daiginjo*. Obviously the higher the polish rate, the more expensive the sake rice, but there are also different varieties as well. California-grown rice that has been polished specifically for sake-making, to between 40 and 60 percent, is available from F.H. Steinbart. Expect to pay $60 for 30 pounds (13.6 kg), the amount needed to produce approximately 5 gallons (18.9 L) of sake.

There are also companies like Minnesota Rice and Milling (MNRice.com), which supply craft sake breweries and homebrewers with polished rice for sake making. They carry Calrose, Koshihikari, Sasanishiki, and Yamadanishiki rice at various polish rates. Calrose is the most common cultivar, and the least expensive, while Yamadanishiki is the finest and most prized variety, but also the priciest. They sell rice in 10- and 25-kilogram bags, and to give you some idea of pricing, two 10 kg bags (44 lb.) of 70 percent polished Calrose will set you back $60 before shipping, whereas the same amount of 50 percent polished Yamadanishiki will cost you $300. The other two varieties are somewhere in the middle at about $150. That sounds like quite an investment, and it is, but you get what you pay for.

If you are lucky enough to have a craft sake brewery in your area, another option might be to purchase bags of polished sake rice (and, for that matter, koji, as most sake makers grow up their own koji rice) directly from the brewery. This is perhaps the best option, as you won't have to pay shipping costs, but you are at the mercy of whatever varieties they happen to have on hand.

Polishing your own rice is technically another option—there are stories on forums involving clothes dryers fitted with perforated steel drums, for example—but from what I understand, the success rate among DIY rice polishers has not been high.

Probably the least expensive option is to make sake with table rice. Unpolished Calrose table rice makes passable sake (though nowhere near the quality of authentic Japanese brands), and it will ferment out to more than 20 percent ABV. Sourcing 50-pound bags of this rice through a big-box store like Costco can make sake making very cost effective for homebrewers just starting out, but as you refine your process and technique, you will probably want to explore the difference a higher-quality rice with a higher polish makes.

Other Ingredients

Other ingredients are fairly easy to come by, though they may not all be available from your local homebrew shop. You will need an 88 percent lactic acid solution (liquid), sanitizer, bentonite or Sparkolloid (wine clarifying agents), and, as previously mentioned, wine yeast nutrient, Epsom salts, and Morton Salt Substitute—these last two can usually be found at the grocery store.

You may also find a silicone antifoam product like Fermcap S to come in handy. Shortly after the last addition of steamed rice, koji, and water, you'll have the full volume of fermenting sake, which can a create prodigious amounts of yeasty foam, even at a low, controlled temperature. Depending upon your fermenter setup, you may want to add the antifoam to control fobbing and overflow.

Why add acid? As with beer, a lower pH protects the ferment from competing bacteria and yeasts. Japanese *toji*, the original sake masters, realized this long ago, so acidity has always been a part of making sake. Over time, there have been a couple of different ways to achieve acidification. The traditional *yamahai moto* method relies on lactic bacteria introduced by using your (clean, but not sanitized) hands to mix the rice. This inoculates your mash with lactic acid bacteria but can result in too much acidity, and it relies heavily on pasteurization toward the end of the process to limit the continued production of lactic acid.

A more modern method called *sokujo moto* is a more hands-off approach and the method I prefer; it doesn't rely on bacteria, but rather on one initial addition of 88 percent lactic acid to the yeast starter. With sokujo moto, mixing is done with sanitized utensils to avoid introducing bacteria. This also keeps total acidity lower and avoids the heavy reliance on pasteurization (though it is still recommended to stabilize the finished product). It means you have to sanitize everything that comes in contact with your sake, just as you would when making beer. A foaming acid sanitizer such as Star San works well for this purpose; iodine sanitizers may add unwanted flavors.

EQUIPMENT

You will also need some specialized equipment. You may already have many of these items on hand: a 3-gallon stainless-steel lidded stockpot to use for the yeast mash, a 5-gallon carboy to use as a secondary fermenter, glass growlers for settling the lees, one or more lengths of transfer tubing, a brew kettle for bulk pasteurization, and, ideally, a temperature-controlled chest freezer or fridge. But the process differs from homebrewing in a few specific ways, so it will be worth investing in some extra equipment just for sake making.

RECOMMENDED EQUIPMENT FOR MAKING SAKE AT HOME

- ❍ Temperature-controlled fermentation chamber or conical
- ❍ Food-grade 30-gallon (114-liter) plastic bin for fermentation
- ❍ Large steamer or equivalent
- ❍ Food-grade bins for mixing rice
- ❍ Thermometer
- ❍ Long-handled, stainless-steel spoon
- ❍ 3-gallon (11-liter) stainless-steel stockpot with lid, or similar vessel (for yeast starter)
- ❍ Freezer and trays for making sanitary ice
- ❍ Accurate scale
- ❍ 5-gallon (19-liter) carboy
- ❍ Transfer tubing
- ❍ Brown glass growlers
- ❍ Brew kettle of at least 15 gallons (57 liters) for pasteurizing bottles or a keg
- ❍ Nylon mesh bags for separation of lees
- ❍ Clean 5-gallon bucket or *fune* press for separation of lees

HOW TO PREPARE AND ADD RICE TO YOUR SAKE FERMENT

Soaking, draining, and steaming rice will each take an hour, so you are looking at close to four hours of work for each rice addition. Fortunately, not all of it is active time. Here's how to do it.

WASHING

To wash rice for the table, it's recommended that you rinse three times in cold water, dumping the turbid, white water with each rinse. With sake, the rice needs to be cleaner: that wash water should run clear. This usually takes six or more washing and draining cycles. Using a large bin for washing can be effective, and scrubbing the rice between your hands can also hasten the process. For larger amounts, I've found that using a large steamer tray and the sink sprayer also helps.

SOAKING

Once the rice is clean and free of dust or talc, scrape it carefully into a large bin and cover it with a couple of inches of cold brewing-quality (charcoal- or RO-filtered) water. Rice will absorb quite a bit of this water as it soaks, and that's what you want: the absorbed water allows steam to gelatinize starches through to the core of each rice grain.

DRAINING

Use a colander or a cheesecloth-lined steamer tray to drain the rice. While it's draining, you can prepare your steamer and get the water to a boil.

STEAMING

Making sure your steamer trays are above your boiling water, steam the rice. Start timing the one hour when you can see steam escaping from the lid over the rice. Rotate the trays every 20 minutes to ensure even steaming, and check on the water level below; you definitely don't want it to run dry.

COOLING AND MIXING

While the rice steams, collect your ice and water and sanitize your mixing vessel, quick-read thermometer, and spoon. Large chunks of ice are best broken up into pieces. (Ice cube trays really help with this but are not strictly necessary.) Dump the hot rice directly from the steamer into the mixing bin and add your ice water. As you stir with the spoon, break down chunks of steamed rice and even out the temperature of the mixture as it cools.

Once your thermometer reads less than 70°F (21°C), you can bring the bin out to your fermenter and add the rice mixture, though continued cooling to 60°F (16°C) or lower is preferable if you can manage it. If chunks of ice remain in the mixture, don't worry, it will melt, and should not adversely affect the main ferment. Colder is always better. Make sure you stir the main mash to integrate each addition and equalize the temperature.

Steamers

The most important of these items is a large steamer. You will steam, not boil, your rice to gelatinize starches before it is added to the ferment. This sanitizes the starch and makes it available to koji enzymes but adds much less moisture than boiling would. The rice kernels remain firm and chewy, allowing parallel fermentation to proceed slowly and facilitates separation of liquid from the solids (known as sake *kasu*) near the end of the process (more on this later).

If you have a large enough brew kettle with a lid, you can suspend and ratchet strap a large cloth over it to fashion a rudimentary steamer. Just make sure to leave enough slack for the rice.

Dedicated metal and bamboo steamers are easily found in large Asian food stores. For this recipe, you'll need one that holds up to 15 pounds (6.8 kg) of rice at once. Make sure you get one with fine perforations rather than large holes in the trays, which will hold in the rice but still allow steam through. You can also line your steamer with cheesecloth to retain the rice. You'll get more even steaming if you limit the number of tiers to two or three, but it's always a good practice to switch around the tiers halfway through the one-hour steam.

Fermenter

You will also need a large 30-gallon (114-liter) fermentation vessel to make a full 5 to 6 gallons (19 to 23 liters) of sake (you can always scale the recipe to go smaller). A food-grade plastic storage bin from a restaurant supply store works great for this purpose, but a temperature-controlled conical also works. If you use a storage bin, it will need to fit into a temperature-controlled chest freezer or walk-in fridge. The handles allow you to wrestle it out, partially filled with sake and kasu, when it's time to rack to secondary (best to have a brew buddy on hand if you have to lift it out of a chest freezer).

Miscellaneous Equipment

Useful but not necessary are food-grade plastic storage bins. These are used as intermediary vessels to mix steaming hot rice and chilled water before adding them to the main fermenter. You'll also need a mixing spoon (stainless is my preference so I can sanitize it easily) and a longer-handled spoon to stir the ferment. This can be a brew spoon or mash paddle if you are confident you can sanitize it before use. It needs to be long enough to reach to the bottom of your fermenter for thorough stirring.

Ice cube trays are a bonus, but you can also freeze water additions in stainless steel bowls—even a partial overnight freeze will work fine. You just need to chill down your fresh-steamed rice quickly so that it can be added to the fermenter at the correct temperature.


Fermenter.


Food-grade bins.


Steamer.

Finally, a sturdy nylon mesh bag, preferably one that will fit in a 5-gallon bucket, is useful for straining the finished sake from the settled sediment (kasu). For this batch size, the mass of kasu is considerable, so you may need help tying it off and suspending it at the correct height; I've used a small aluminum ladder to hang the bag of lees in my garage for several hours, but you can also use several small bags if a single large bag is unmanageable. Brew-in-a-bag brewers who use pulley systems will have an advantage here.

People who are a little more serious about their equipment may want to build a homebrew-sized replica of a real *fune* press to separate sake from lees. In many commercial sake breweries, the combined, fermented mass of rice, yeast, and koji solids (called *moromi*) is scooped into strong mesh bags and stacked into a perforated tub. Then another non-perforated tub is fitted over them and filled with water. This presses the sake from the bags, leaving the dry kasu solids behind.

With a little creativity and a visit to a restaurant supply store, you can acquire a series of the aforementioned food service storage bins and modify one with perforations, as long as they are large enough to hold the entire moromi. A bin below the perforated one can be fitted with a drain hole and spigot for passing the pressed liquid through a piece of tubing and into your carboy for conditioning. See BostonSake.com for an example of a homebrew-sized *fune* press; it's a great site and has tons of sake-brewing tips, equipment, and information.

The heavy-duty mesh bags need to be strong enough to take the pressure of the press, as well as be sanitizer-friendly and made of food-grade material, but they are pretty easy to source.

PROCESS

Once you have collected the equipment and ingredients for your batch, you can begin planning out the process and building your timeline or calendar. The first week is relatively simple. You'll build up and ferment your yeast starter of treated water, nutrients, koji, and steamed, cooled rice. This "seed mash," called *shubo*, will then ferment for several days to build up the yeast. Most of the real work takes place during the second week. That's when you double the volume of your starter three times; these additions of water, koji, and rice are called, in order, *hatsuzoe*, *nakazoe*, and *tomezoe*.

Koji always gets added to the ferment the night before you steam your next rice addition. Initially you add it to the *shubo* yeast mash, but once the rice and water are added the next day, the whole yeast starter is then transferred to your main fermenter. At the same time, koji is measured and added the night before, the water addition is measured, with part of it, covered and sanitary, going into the freezer. This is so that when you finish steaming your next addition of rice the next morning, you can mix it with ice water to bring the hot rice down quickly to at most 70°F (21°C) before adding it to your active ferment. With the third doubling, you'll be processing 15 lb. (6.8 kg) of rice: washing, soaking, draining, steaming, and then mixing with ice water.

For details, see the sidebar How to Prepare and Add Rice to Your Sake Ferment on page 50.

TABLE 1: BUILDING YOUR SAKE FERMENT, STEP BY STEP

Day	Morning	Evening
1		Activate Smack Pack if using Wyeast.
2		Prepare 1,860 mL water for *shubo* (seed mash). Freeze 360 mL of the water for morning of Day 3. Keep remaining 1,500 mL covered at room temperature.
3	***Shubo* Prep** Add yeast and 345 g koji to 1,500 mL water prepared on Day 2. Steam 1,020 g rice and mix with prepped ice to chill. Blend cooled rice/water mixture with yeast, koji, and water. Leave *shubo* at room temperature."	Stir *shubo* thoroughly.
4	Stir *shubo* thoroughly.	Stir *shubo* thoroughly.
5	Stir *shubo* thoroughly.	Stir *shubo* thoroughly.
6	Stir *shubo* thoroughly.	***Hatsuzoe* Prep** Add 675 g koji and 1,065 mL water to *shubo* and stir thoroughly. Freeze 885 mL water for morning of Day 7. Set temperature of ferment to 55˚F (13˚C).
7	***Hatsuzoe*** Maintain temperature of ferment at 50˚F (10˚C). Steam 1,710 g rice and mix with prepped ice to chill. Blend cooled rice/water mixture into *shubo* to begin *odori*.	Stir *odori* thoroughly.
8	Stir *odori* thoroughly.	***Nakazoe* Prep** Add 1,020 g koji and 3.6 L water to fermenter and stir thoroughly. Freeze 2,610 mL water for morning of Day 9. Maintain temperature of ferment at 50˚F (10˚C).
9	***Nakazoe*** Set temperature of ferment to 45˚F (7˚C). Steam 4.08 kg rice and mix with prepped ice to chill. Blend cooled rice/water mixture into fermenter."	***Tomezoe* Prep** Add 1,362 g koji and 12.9 L water to fermenter and stir thoroughly. Freeze 2,610 mL water for morning of Day 10. Maintain temperature of ferment at 45˚F (7˚C).
10	***Tomezoe*** Maintain temperature of ferment at 45˚F (7˚C). Steam 6.8 kg rice and mix with prepped ice to chill. Blend cooled rice/water mixture into fermenter. Add antifoam agent if using.	Stir *moromi* thoroughly.
11	Stir *moromi* thoroughly.	Stir *moromi* thoroughly.
12 and beyond	Let fermentation proceed. Optionally adjust with water. Rack, pasteurize, and package.	

Temperature Control

Sake yeast ferments well at low temperatures, much like lager yeast, but the seed mash or *shubo* should ferment at 70°F (21°C) to maximize cell growth. It's essentially a yeast starter. After a week of this, lower the *shubo* mash temperature to 55°F (13°C).

Once the doubling additions begin, your sanitized, main fermenter should be placed in a temperature-controlled environment so that you can lower the temperature with each addition.

The first addition (*hatsuzoe*) should equalize at around 55°F (13°C) once the yeast mash is added, and it should be cooled slowly to 50°F (10°C) during fermentation. This "primary" fermentation stage is now called the *odori*, or dancing ferment, and you will get some delicious bready, fruity aromatics as it bubbles away.

The middle addition (*nakazoe*) should also equalize at close to 55°F (13°C) and the ferment should continue at 50°F (10°C) after this addition.

The final addition (*tomezoe*) will equalize at close to 50°F (10°C) and should then be cooled to 45°F (7°C), from which point, the main ferment should proceed at 45°F (7°C). At no point should the main ferment exceed 55°F (13°C).

Stirring

As fermentation takes place, be it in the seed mash or in the main ferment, stirring is critical. You will have to stir every 12 hours to keep the fermentation in balance. Agitation keeps starches in contact with enzymes and the resulting sugars in contact with yeast. The rice, koji, and yeast mixture is slowly broken down from semi solid to mostly liquid during fermentation, so regular stirring is necessary, at least initia, to evacuate CO_2, and hasten the breakdown of solids.

Once you have completed the three doubling additions and all the ingredients are in the fermenter, everything needs to be cooled way down to 45°F (7°C) so that the yeast can do its thing.

Ferment This!

Sake

Batch volume: 5–6 US gal. (19–23 L)

RICE

30 lb. (13.6 kg) polished sake rice or sushi rice
7.5 lb. (3.4 kg) koji rice

YEAST

Wyeast 4134 Saké

ADDITIONAL ITEMS

8 mL 88% lactic acid
12 g wine yeast nutrient, optional
2 g Epsom salts, optional
21 g Morton Salt Substitute (only this brand), optional
optional bentonite or Sparkolloid for clarifying
optional Fermcap S or Fermcap AT for foam control

WATER

6 gal. (23 L) reverse osmosis or distilled water

PROCESS

See full text of article for details on the lengthy but straightforward sake-making process.

This is the main ferment, or moromi, and it will last at least one week, depending on your fermentation temperature. With temperature control and a cold ferment, which is ideal, the main ferment can take up to two weeks. The final *yodan* stage is the adjustment stage, during which water is added to bring the 18–20% ABV final product from full-strength (*genshu*) sake down to an easier-drinking 15–16% ABV by diluting with RO water.

We'll look at each one of these in turn as we go through the process schedule. The schedule is also summarized in Table 1.

Day 1
If using Wyeast 4134, activate the Smack Pack. Otherwise, bring your yeast to room temperature and proceed to Day 2.

Day 2
Prepare water by mixing the following:

- 1,860 mL RO or distilled water
- 8 mL 88% lactic acid
- 12 g wine yeast nutrient, if using
- 1.4 g Epsom salts, if using
- 21 g Morton Salt Substitute, if using

Blend water to fully dissolve solids. Remove 360 mL of this mixture, cover and freeze overnight. Cover the remaining 1,500 mL and keep at room temperature overnight.

Day 3 (Morning)
Measure and prepare 1,020 g rice by washing, soaking, and draining it. While you are waiting for it to soak one hour and drain one hour, add the contents of the inflated yeast pack to the 1,500 mL prepared water, working with maximum sanitation. Measure and add 345 g koji to the yeast and water mixture. Cover and let stand at room temperature.

Meanwhile, steam the rice, checking it mid-steam to make sure you have enough boiling water for the full one-hour boil. Have your mixing tray, spoon, stockpot with lid, thermometer, (all sanitized) and 360 mL ice ready. As soon as the rice is done, pour it into the tray, stir in the ice, and break up any chunks; you should soon have a 70°F (21°C) or cooler mass of rice of uniform consistency. Blend the cooled rice with the yeast, water, and koji mixture in the sanitized stockpot, cover, and leave at room temperature.

Day 3 (Evening)
Twelve hours after blending the *shubo* mash, sanitize your steel spoon and stir the mash gently for about five minutes. You will need to repeat this every 12 hours (twice daily) for three more days.

Days 4–6
Stir the *shubo* mash as above, every 12 hours. After the third day of fermentation at room temperature, you can leave the yeast mash alone until you are ready to begin the main ferment. Depending upon your calendar, you may want to wait a full seven days so you can start the main ferment on a weekend—that's fine. If this is your plan, the evening of Day 6 is when you'll prepare for the first main addition on the morning of Day 7.

Day 6: *Hatsuzoe* Prep (Evening)
The night before you start the main ferment, you'll need to measure out 675 g koji and add it to your *shubo* yeast mash along with 1,065 mL RO water. Now is the time to have your sanitized, plastic main fermenter and lid in a clean temperature-controlled environment. Set the temperature to 59°F (15°C) and place the covered stockpot with the yeast mash in it. Now, measure out 885 mL and freeze it for the next morning's steamed rice.

Day 7: *Hatsuzoe* (Morning)
In the morning, measure and prepare 1,710 g rice by washing, soaking, and draining it as above. While you are waiting for it to soak one hour and drain one hour, cool the fermentation chamber with the main fermenter to 50°F (10°C). When the washed and soaked rice is fully drained, steam it, checking it every 20 minutes to swap trays and to make sure you have enough boiling water for the full one-hour boil. Have your mixing bin, spoon, stockpot with lid, thermometer, (all sanitized) and 885 mL ice ready.

As soon as the rice is done, pour it into the bin, stir in the ice, and break up any chunks; you should soon have a 55°F (13°C) or lower mass of rice and water, of uniform consistency. A lower temperature is better—try to get it to 50°F (10°C) if possible. This will put less stress on your yeast. Blend the cooled rice into the main ferment thoroughly. Cover.

Day 7 (Evening)
Twelve hours after you've added your first main rice addition, stir the contents of the fermenter thoroughly with a sanitized spoon. Make sure you reach all the way to the bottom of the fermenting rice mixture. Repeat at 12-hour intervals for a total of 48 hours.

Day 8 (Morning)
Stir the main ferment as above.

Day 8: *Nakazoe* Prep (Evening)
Now you will prepare for the second main rice addition. Measure out 1,020 g of koji and 3.6 L RO water and add both to the main fermenter. Stir thoroughly, as you have been doing every 12 hours. Measure 2,610 mL of additional RO water and freeze it for your rice steaming tomorrow morning. At this point, your chest freezer should still be set to 50°F (10°C) and hopefully your active ("dancing," or *odori*) ferment shouldn't be much warmer than 55°F (13°C).

Day 9: *Nakazoe* (Morning)

In the morning, measure and prepare 4.08 kg rice by washing, soaking, and draining it as above. While you are waiting for it to soak one hour and drain one hour, lower the chest freezer with the main fermenter in it to 45°F (7°C). When the washed and soaked rice is fully drained, steam it, checking it mid-steam to swap trays and to make sure you have enough boiling water for the full one-hour boil. Have your mixing bin, spoon, stockpot with lid, thermometer, (all sanitized) and 2,610 mL ice ready.

As soon as the rice is done, pour it into the bin, stir in the ice, and break up any chunks; you should soon have a 55°F (13°C) or cooler mass of rice and water, of uniform consistency. A lower temperature is better—try to get it to 50°F (10°C) if possible. This will put less stress on your yeast. Blend the cooled rice into the main ferment thoroughly. Cover.

Day 9: *Tomezoe* Prep (Evening)

Now you will prepare for the third and final main rice addition. Measure out 1,362 g (or whatever is left of the) koji and 12.9 L RO water and add both to the main fermenter. Stir thoroughly, as you have been doing every 12 hours. Measure 2,610 mL of additional RO water (yes, this is the same volume you froze for the previous addition) and freeze it for your rice steaming tomorrow morning. Maintain your chest freezer at 45°F (7°C) and hopefully your ferment shouldn't be much warmer than 50°F (10°C).

Day 10: *Tomezoe* (Morning)

This is the big one. In the morning, measure and prepare 6.8 kg (yup, that's 15 lb.) rice by washing, soaking, and draining it as above. While you are waiting for it to soak one hour and drain one hour, check that the main ferment is around 45–50°F (7–10°C). When the washed and soaked rice is fully drained, steam it, checking it mid-steam to swap trays and to make sure you have enough boiling water for the full one-hour boil.

Check the rice to make sure it is steaming evenly; with this large a volume, you may want to stir the rice in the trays when you swap them, just to make sure everything is cooking (gelatinizing) as it should. Have your mixing tray, spoon, stockpot with lid, thermometer, (all sanitized) and 2,610 mL ice ready.

As soon as the rice is done, pour it into the tray, stir in the ice, and break up any chunks; you should eventually have a 50°F (10°C) or cooler mass of rice and water, of uniform consistency. A lower temperature is better—try to get it as close to 45°F (7°C) as possible, but don't worry if it's warmer than that—the large fermentation volume will bring the new addition down to the proper temperature quickly.

Blend thoroughly. Take a deep breath of the delicious, estery aromas—banana, melon, black walnut—rising from your fermenter. If the fermenting volume looks as though it might foam up beyond your fermenter's capacity, you might consider adding a small amount (3 mL) of silicone antifoam, sanitized in 10 to 15 mL boiling water to keep it under control. Cover.

Days 10 and Beyond: Stirring and Fermentation

From here, your only task will be to stir the main ferment every 12 hours for the first two days (48 hours) of fermentation. Keep the temperature set to 45°F (7°C) or as near as you can manage. Make sure your sanitized brew spoon is long enough to reach all the way to the bottom of the fermenter.

At the low end of the temperature range, fermentation can take up to two weeks. At higher temperatures, which may be as high as

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50°F (10°C), though this is not recommended, it can be over in a week. Begin taking gravity readings of the moromi after about six days. Once the sake begins to approach 1.000 specific gravity (see *yodan* stage below), you can begin to consider racking.

After Fermentation: Water Adjustment (*Yodan*)

Depending on whether you used highly polished sake rice or table rice, the strength of your uncut, full-strength (*genshu*) sake will vary a bit. Polished rice will give you a final strength of around 18% ABV, while table rice will be around 20–22% ABV. This will also vary with how dry you'd like it.

If you like sweeter sake, rack the sake sooner—at 1.003 specific gravity—which equates to –4.3 on the sake sweetness scale (Sake Meter Value, or SMV), if you are familiar with authentic, high-quality bottled sake. If you prefer a drier product, wait a little longer, until the sake has attenuated to 0.995 specific gravity (+5.8 SMV). Personally, I prefer bone-dry, *genshu* sake of +15 SMV, so I wait until it reaches 0.990 before racking and clarifying. It takes more time, as the yeast is understandably exhausted by this time, but with table rice, it is definitely capable of reaching this level of dryness.

But if you'd rather not have *genshu* sake and would like to target a more conventional strength, then regardless of how sweet your finished sake is, you'll want to add water to bring the ABV down to 15% to 18%. Be careful about adding too much water—it's much like adding salt in that you can't undo it. For this batch size, an addition of 2.3 to 2.6 liters of boiled, chilled RO water will put you in the 16.5% ABV range.

Why boiled? At this stage you need to be very careful about oxygen uptake. As with finished beer, your alcoholic beverage now is very susceptible to oxidation, and oxygen can add cheesy flavors and aromas to sake. It can also color it an unattractive yellow. Your sake, if made with table rice, will already have more color than most store-bought brands made with polished rice, especially if you choose to go the *genshu* route. But please take every precaution to keep oxygen out, and if you choose to dilute your sake, that means removing as much oxygen from the water addition as possible; so boil it a good 15 minutes and chill it before adding.

Adding this DO (de-oxygenated) water addition prior to racking allows whatever yeasts are still on duty to scavenge and metabolize any remaining traces of oxygen and hopefully leave you with a largely oxygen-free final product.

RACKING AND SEPARATION OF LEES

After two full weeks of primary fermentation (and if you've added water, wait another three days), your sake will be ready to rack. Have a brew buddy help you lift the primary fermenter up, out of, and onto your chest freezer or other elevated surface.

Use a sanitized siphon hose to rack as much liquid as you can off the top of the fermenter and into a sanitized 5-gallon bucket lined with your sanitized nylon mesh bag. Or, if you're using a *fune* press, scoop the moromi into sanitized mesh bags and place them in the press. Again, be mindful of oxygen during this process. I usually dose the receiving bucket with CO_2 and try to limit splashing as much as possible.

The sake will be milky white, and there may be suspended solids that will eventually clog your transfer hose. That is normal; your nylon mesh bag will catch the solids. Get as much liquid as you can, and then use your transfer hose to rack the filtered liquid from outside of your nylon mesh bag to a sanitized, CO_2-purged, 5-gallon carboy.

The solids from the fermenter can now be transferred to the mesh-lined bucket. Once all the solids are in the nylon bag, it can be gathered and tied at the top, then lifted gently to allow liquid trapped in the kasu to drain into the bucket; that liquid can then be racked into the carboy. You should be able to fill the carboy to the very neck and still have around a gallon (roughly 4 liters) of sake left if you let the bag drip for several hours or overnight. With the *fune* press, you should be able to recover even more liquid from the kasu solids.

Add a stopper and airlock to the carboy and place it back into your temperature-controlled fermentation chamber at 45°F (7°C) to settle. It may ferment a bit more, as you will have released some starches and sugars during the racking and pressing of the lees. That's fine, and the yeast should be able to scavenge some of the accidentally introduced oxygen as well.

The remaining sake that drips into the bucket can be bottled up into one or more glass growlers (brown glass if possible, as your sake is susceptible to damage from light at this stage, as well as from oxygen). Use stoppers and airlocks for all secondary containers and try to fill them up to the neck with sake. Eventually, after a full night of your bag of kasu draining, the dripping will slow. It is possible to use a wine press at this stage to squeeze every last drop of sake from the kasu. Check the carboy and growlers in your chest fridge periodically to monitor clarity. Sparkolloid or bentonite can be used as fining agents to speed up this process, which can

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WE PRODUCE OVER **40** DIFFERENT PRODUCTS take up to two weeks. Once it has reached your preferred level of clarity (and you may want to rack it off the lees into separate sanitized carboys), the clear sake can then be pasteurized and packaged.

And don't throw away that kasu! It's great as a marinade for fish, steaks, and chicken. It can be baked into bread dough for a super-crispy crust (and it makes an amazing pizza crust). Or it can be used to make traditional Japanese pickles. The culinary uses are endless—just search online for sake kasu recipes. Bagged kasu will keep just fine in the freezer or fridge.

PASTEURIZATION AND PACKAGING

I use the term *pasteurization* loosely—Japanese sake masters (*toji*) discovered long before Louis Pasteur's time that heating finished sake for a brief period before packaging preserved its quality. The enzymes in the koji are deactivated, yeast metabolism is halted, and any live bacteria residing in the beverage are shut down.

The process basically stabilizes the sake so that it can be kept for several months at room temperature. Of course, if you have the fridge space, you don't have to pasteurize at all, but you'll have to keep this unpasteurized sake at 33°F to 40°F (1–4°C) until it is consumed. This "fresh" active sake is called *nama* and is often referred to as "draft sake."

If you choose to bottle and heat-stabilize your sake, it can be pasteurized right in the bottle by using your trusty stockpot on the stove. Fill the stockpot half full of water, put in as many bottles of sake as will fit in the bath, and slowly heat the water to 149°F (65°C). Make sure the water bath rises to the level of the sake in the bottles.

Sanitize a thermometer and stick it in one of the bottles to monitor sake temperature; when the sake reaches 149°F (65°C), you may remove the bottles, cap them, and allow them to cool, repeating the process with additional bottles as necessary. Make sure the caps you use are boiled to sanitize them. Ordinary bottle caps are fine, but oxygen-scavenging caps are better. Please don't use real wood corks, as they will taint the delicate flavor of the sake; artificial corks should be OK.

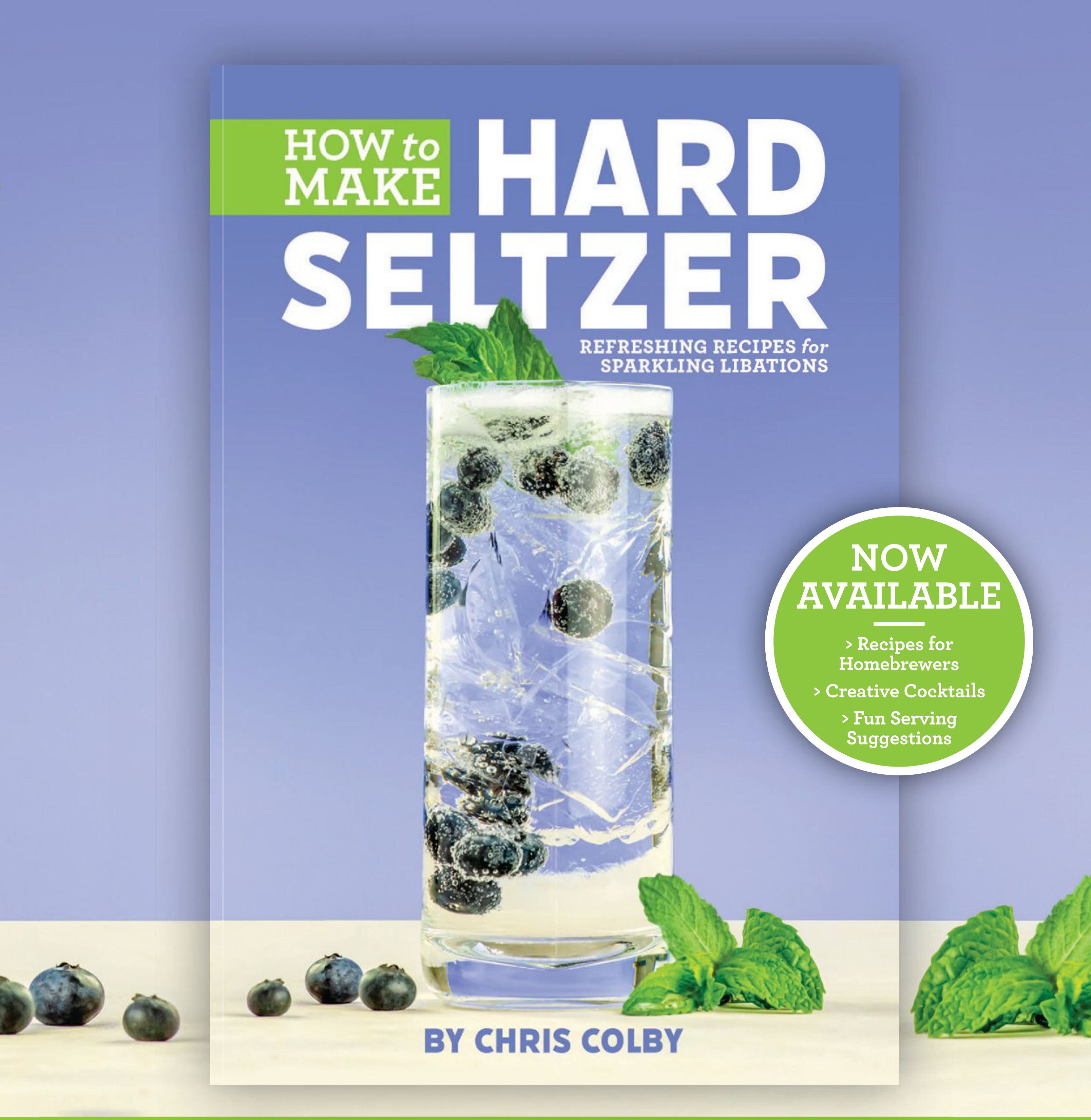
If you like the idea of sake on tap, you can rack your clear sake to a 5-gallon Corny keg, which *could* be pasteurized in bulk if you have a large enough brew kettle, but the amount of time needed to heat it to 149°F (65°C) and cool it back down will result in cooked sake. If you keg your sake, it's much simpler to keep it as unpasteurized *nama* sake, as long as it remains refrigerated. For an extra twist on *genshu* sake, you can even force-carbonate the cold sake in the keg and serve it sparkling, or bottle it from the keg using a counter-pressure filler.

Sparkling sake may also be refermented in the bottle, although fresh yeast and dextrose may be needed. Bottling force-carbonated sake from the keg, however, is more reliable. There is something beautifully Champagne-like about a chilled, highly sparkling, 20% ABV, bone-dry, sediment-free, bottled *genshu*. It definitely adds a spritzy dryness to the beverage, which I find quite to my taste. You might as well.

RESOURCES

The methods in this article are based on Fred Eckhardt's classic New Sake Recipe, which can be found at designerinlight.com/eckhardt-sake.pdf. A simpler method for making sake at home may be found at Todd Bellomy's BostonSake.com.

Amahl Turczyn continues to brew and write at his home in Lafayette, Colo.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TRADITIONAL MEAD STEPS FOR SUCCESS

Tips from the AMMA Home Governing Committee

Making traditional mead is all about showcasing the honey and allowing specific elements of the varietal to shine.

By
Annie Zipser,
Amy Olsen,
Andrew Luberto,
Kevin Meintsma,
Carvin Wilson,
and Matt Weide

Homebrewers are spoiled for choice when it comes to advice for making beer, but meadmaking can sometimes seem overwhelming to the uninitiated. Honey isn't cheap, so when you set out to make a batch of mead, you want as much solid information as you can get.

Not to fear! Several members of the American Mead Makers Association's (AMMA) home governing committee are here to share their tips for making your best traditional mead. Keep reading for the steps for success! →

Valkyries Horn glasses.

ANNIE ZIPSER

While I generally make a traditional with any new honey that I get, two varieties have been my favorites. These honeys are Trader Joe's 100% Desert Mesquite Honey and Gibbons Honey Farm's Nebraska Sweet Clover. I make sweet, dessert-style meads.

I start with 4 pounds of honey per gallon of mead (480 g/L). I use tap water (I have good water), which I prepare with part of a Campden tablet. After my honey is in the fermenter, I add a couple of cups of warm water and get it stirred in. When the honey has completely dissolved, I add the rest of the water and bring the mixture to the 1-gallon (3.8-liter) mark. I stir for a couple of minutes with a stirring attachment on my drill.

When the mixture is room temperature, I add yeast. I like using Lalvin K1V-1116 for my traditional meads, and I rehydrate it with GoFerm. I use Fermaid K and diammonium phosphate (DAP) as staggered nutrient additions (SNA), which I add for the first four days of fermentation, taking care to degas the mead before adding nutrients. After three to four weeks, I rack to secondary. I ferment in my basement where the ambient temperature is usually 60°F to 62°F (16–17°C).

I bulk age my meads for about a year and then fine using Kieselsol and chitosan if necessary (I find that my traditional meads don't clarify as well as other types). Two weeks after fining, I am ready to bottle.

AMY OLSEN

I have a list of personal mead goals. One I have been working on for a couple of years is trying to perfect traditional mead. For me, traditionals are all about showcasing the honey and doing what you can to allow specific elements of the honey to shine. To really design a great mead, there need to be layers of flavors and complexity.

I start by selecting the honey. I taste a lot of raw product and decide what about each honey I would like to showcase. A favorite varietal honey of mine is Hawaiian Lehua. It has a distinct floral character and a beautiful, nearly toffee-like buttery flavor that works extremely well in traditional meads.

With these qualities in mind, I select the yeast. I have used other yeasts before, but the next one that I am excited to try with this honey is Lalvin BA11. I am specifically selecting it for ester production to enhance the tropical flavors and creaminess in this honey, as well as for the increased mouthfeel it will lend.

I rehydrate dry yeast with GoFerm. While that happens, I weigh out the honey. I am from the sugar belt and generally prefer sweeter mead. For a standard mead, I use about 3 pounds of honey per gallon (360 g/L), and I typically make 6- to 8-gallon batches (23–30 L). I dissolve the honey with warm tap water—I am fortunate to have great water!—and then I aerate the must for about 5 minutes with a whip attachment on my hand drill.

I make sure that the water is no warmer than 104°F (40°C) when I pitch the yeast. I have recently started experimenting with fermentation tannins and additives such as Opti-White and Opti-Red. If I include such additives, this is when I do that.

I usually use the BatchBuildr at MeadMakr.com to determine my nutrient schedule. Lately, I have been using a combination of DAP, Fermaid O, and Fermaid K to feed my mead. I follow the standard nutrient schedule for the 72 hours after pitching, and I also degas and rouse the yeast. It is often suggested to degas three to four times per day, but I will be honest: I usually only do it once a day right before I add nutrients.

The temperature in my basement is about 64°F to 68°F (18–20°C). Depending on my chosen yeast's temperature requirements, I sometimes use a fermentation chamber, which in my case is a small chest freezer with a carboy heater taped to the inside and connected to an Inkbird temperature controller.

About three weeks or so after pitching, when fermentation is complete, I rack the mead to secondary. I then bulk age it until I feel that it is ready, usually six to nine months. I stabilize my mead with sorbate and sulfite and back-sweeten after 24 hours if necessary.

Then, I fine my mead using Kieselsol and chitosan. After adding those, I usually wait 24 to 72 hours before bottling. I use an Enolmatic vacuum filler to do my bottling. I am a stickler for clarity, especially if I am competing, so, I use a 0.5-micron filter as part of my bottling process.

ANDREW LUBERTO

I'd wager that traditional meads are probably the least represented meads in home meadmaking. At New York's 2019 First Round site of the National Homebrew Competition (NHC) site, we received exactly two entries. One might assume, then, that traditionals aren't very popular among home meadmakers, but nothing could be further from the truth.

There are some fierce defenders of traditional meads, and rightfully so. When made correctly, they offer a wonderful platform for outstanding honey. When I first started meadmaking, I focused mostly on traditionals because I wanted to get the basic process of meadmaking down (whatever that means) before venturing off into what I imagined was more challenging meadmaking.

I have no idea if this approach made me a better meadmaker or not, but it did give me an idea of what I like and don't like in traditional meads. I tend to go sweeter with my traditionals (final gravity of 1.020 or more) at the moment because I think sweeter mead showcases the honey better than drier versions.

For my recipe on page 70, I used a varietal from one of the monthly AMMA deals—which are amazing, by the way, and worth the price of membership alone—which was hairy vetch honey from Yirsa Farms in Montana. I became interested in hairy vetch honey a few years ago after I judged a mead made by Warren Earle at the best-of-show table at my club's annual mead competition. I had never heard of the variety before and thought it sounded a little like a 1970s adult film, but I was blown away at the flavor in Warren's mead.

The honey has beautiful vanilla, Juicy Fruit, and cream soda notes that I find elegantly expressive. Warren actually posted his recipe on the Modern Mead Makers Facebook page, and I highly suggest checking out that recipe. When making a traditional mead, you need an expressive, interesting honey to carry it off; otherwise, your product will seem a bit dull and one-dimensional.

For yeast, I chose Bootleg Biology Chardonnay because I wanted something with some mild phenols to accent the vanilla character of the honey that could also tolerate the alcohol content for which I was aiming. I fermented fairly cool, as I was trying to restrain harsh fusel alcohols, and the yeast seemed to tolerate it well.

KEVIN MEINTSMA

At this stage in my meadmaking "career," I've made very few traditional meads—eight I think. I waited until I felt like I had a solid understanding of my process and some small amount of knowledge about varietal honey characteristics, and now traditionals are now near the top of my list of challenges. I am in the process of making traditional meads from every varietal honey I own, with more on the way (thanks, AMMA!). The few traditionals I have created to date were all made following this same process, and all have been entered in competitions, where they've done very well. This method was "borrowed" from Josh Mahoney.

I ferment a 5-liter batch on a stir plate with an airlock, using reverse osmosis water mixed with the honey—usually about 3 pounds (1.36 kg)—to a volume of 5 liters at 1.085 (20.5°Bx) starting gravity. My go-to yeast the first time through is Lalvin DV10 because it is fairly neutral, allows me to identify the varietal character of the finished mead, and works well at the customary ambient temperature of 64°F (18°C) in my basement.

I use 2.25 grams of yeast rehydrated with 3.5 grams of GoFerm, and nutrients are all front-loaded for this gravity. I use Fermaid O with a total dosage of 3.4 grams for this volume. Mouthfeel enhancers are added at yeast pitch and include 1.2 grams of Opti-White and 1 gram of FT Blanc Soft. I add pure oxygen at the lowest flow I can manage for 30 seconds.

When the mead is 50 percent through fermentation (usually by day three), I add an appropriate dose of bentonite. At terminal gravity, I rack to a 1-gallon glass fermenter with airlock, and the remaining volume goes into a wine bottle with an airlock to be used for top up if needed later. I stabilize the mead, back-sweeten if needed, and add acid if needed to balance, usually tartaric acid.

When the mead has fully cleared, I rack again and top up with the leftover volume to make a total volume of 1 gallon. I do not filter small batches; instead, I rely on time and clarifying agents if the mead is being stubborn.

Sometimes, the yeast doesn't pair well with the honey, so I'll start making decisions about the next yeast I want to try based on my tasting evaluation of the mead and my experience with different yeasts. I take meticulous notes to inform me about the next iteration I want to make with a particular honey.

I like making traditional mead at this gravity because it allows a fast turnaround and I can regulate the amount of alcohol produced. It also provides me with a consistent standard for evaluation, and making a dry mead really tests the varietal character of the honey. I've won at Mazer Cup, Minnesota Mashout, NHC First Round, and other competitions using this method. Give it a try and see if it works for you.

CARVIN WILSON

This approach has won multiple Mazer Cup, NHC, and other competition awards. Many meadmakers have used it over the last few years with great results.

The star in a traditional mead will always be the honey, so choose something that will stand out. My preferred honey varietals are meadowfoam, orange blossom, tupelo, leatherwood, fireweed, coffee blossom, passion fruit, sage, buckwheat, and heather, but the goal is to choose a honey that will stand out with distinct character. Also, go the extra mile and carbonate the mead if possible.

My preferred yeasts for traditional meads are Lalvin DV10, QA23, Sensy, and D47, depending on the variety of honey. My go-to is DV10, which I like because it does not add character and gets out of the way of the honey. It's really hard to screw up a traditional mead with DV10: it's low in yeast assimilable nitrogen (YAN) and will do an excellent job if you can control your fermentation temperature. Opti-White and FT Blanc will give your mead a wine-like mouthfeel, but even reducing the starting gravity down to 1.080 (19.3°Bx) will still result in a wonderful mouthfeel.

I always use GoFerm to rehydrate yeast for mead. The formula is 1.25 grams of GoFerm per gram of yeast, so to rehydrate a 5-gram sachet of yeast, you would need 5 grams × 1.25 = 6.25 grams of GoFerm. You calculate the amount of rehydration water in grams by multiplying the GoFerm amount by 20, which would give you 125 grams of water for a typical 5-gram yeast packet with 6.25 grams of GoFerm.

I only use RO water, which I heat to 110°F (43°C), and then add the GoFerm. I usually add the yeast at around 90°F (32°C), after which I pull some must and slowly temper the yeast mixture until it's within 10°F (6°C) of the must temperature. Whatever you do, don't let the rehydrated yeast sit for more than 15 minutes without adding some must.

Prior to pitching yeast, hit the mead with 30 seconds of oxygen. Make sure you mix the must extremely well. FT Blanc and Opti-White are added as part of primary fermentation. Ferment at 62°F (17°C).

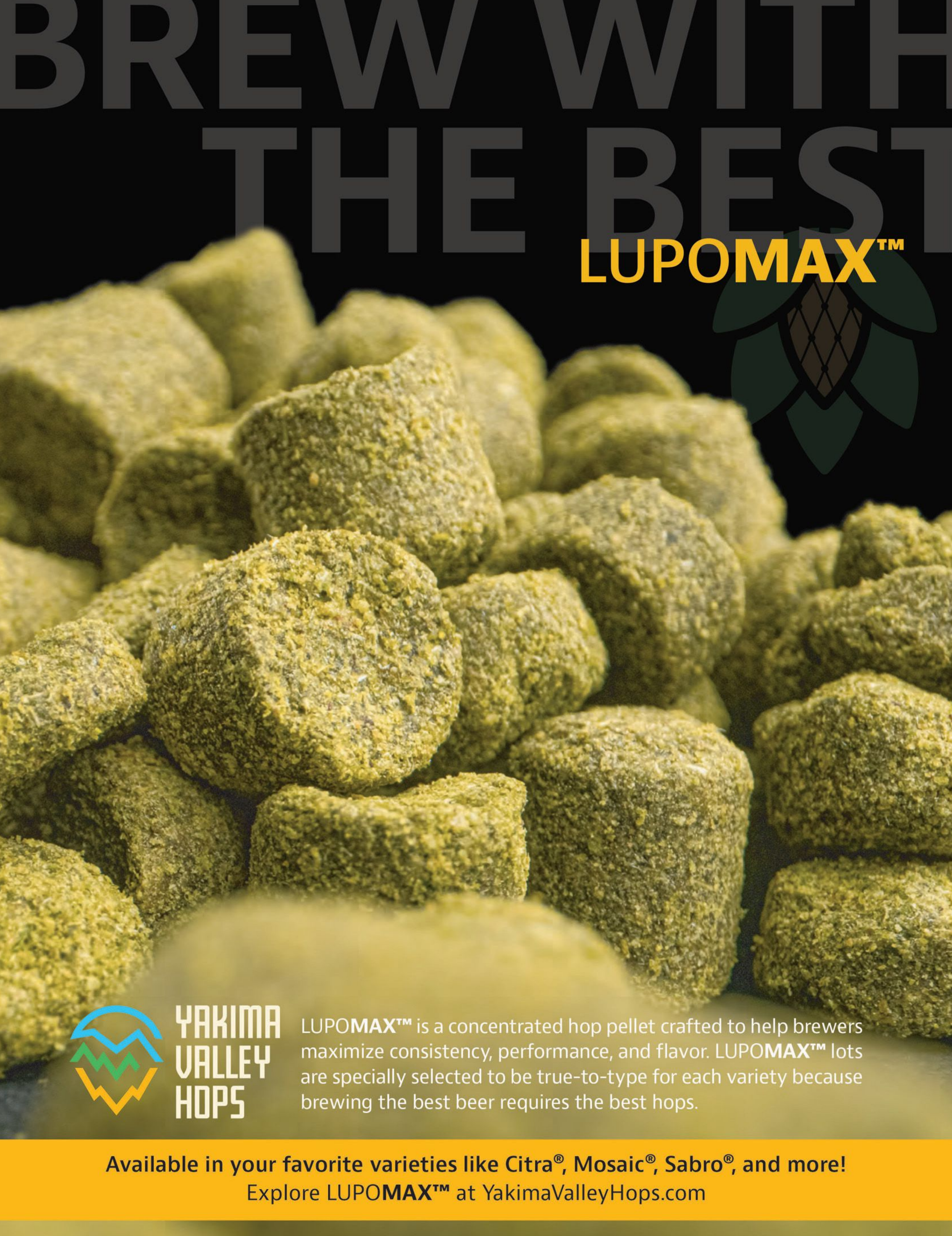
I mostly use Fermaid O for traditional meads, which I dose according to this formula:

$$\text{Fermaid} = 0.2 \times \text{Brix} \times \text{YAN} \times \text{Gallons}$$

DV10 is a low-YAN yeast, hence 0.75 for YAN. So, for a 1-gallon batch of 25°Bx must, the total amount of Fermaid O would be

$$0.2 \times 25 \times 0.75 \times 1 = 3.75$$

Thus, we'd add 3.75 grams of Fermaid O in 4 doses of roughly 1 gram per feeding. In this case, that would be about 1 gram of Fermaid O at 24, 48, 72, and 96 hours after pitching yeast. If you are going to ferment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Ferment This!

Orange Blossom Traditional Mead

Recipe courtesy Matt Weide.

This is a quick, easy recipe that I have found to work very well. I like using Lalvin 71B yeast, which can withstand high osmotic pressure from the sugar.

For an interesting variation, try replacing 10 percent of the orange blossom honey with a complementary varietal like quince blossom honey, which also has floral fruity notes that will provide layers to your final mead

Batch volume: 3 US gal. (11.4 L)

HONEY

12 lb. (5.44 kg) orange blossom honey

WATER

2.5 gal. (9.5 L) RO or spring water, UV treated

YEAST

15 g Lalvin 71B

ADDITIONAL ITEMS

20 g GoFerm
10 g Fermaid K, divided into three additions

PROCESS

Rehydrate yeast in GoFerm and about 350 mL water at 100°F (38°C) and let sit for 15 minutes. Mix the honey with water using a wine whip and add O_2 with a sintered stone for 60 seconds.

Atemper the yeast and GoFerm solution with about 50 mL of must every 5 minutes until it is within 10°F (6°C) of desired pitch temperature. In the first 24 hours, add another 60 seconds of O_2 and ⅓ of the Fermaid K. On day 3, add ⅓ of Fermaid K, and then add the remaining ⅓ on day 5. Be sure to vigorously wine whip twice a day in first 72 hours to degas. After the third day, I try to not form a convex cone so as to not draw O_2 into the must, but I do continue to stir for at least 7 days.

your mead cooler than 60°F (16°C), I suggest changing the YAN to 1.25 versus 0.75, which would yield 0.2 × 25 × 1.25 × 1 = 6.25 grams of Fermaid O, or about 1.5 grams per feeding. Always degas your mead prior to adding nutrients.

If you back-sweeten your mead, you need to stabilize it so fermentation does not

Ferment This!

Hairy Vetch Traditional Mead

Traditional mead

Recipe courtesy Andrew Luberto.

This recipe is written for a 1-gallon (3.8 L) batch, but you can make it whatever volume you like by scaling the quantities accordingly. Remember to include the volume of the honey in your water calculations—12 pounds of honey occupies one gallon (1.44 kg/L). So, if you make a 4-gallon (15.1 L) batch, you would need only 3 gallons (11.4 L) of water since the honey will bump up the batch volume to 4 gallons (15.1 L) total.

Batch volume: 1 US gal. (3.8 L)
Original gravity: 1.112 (26.4°Bx)
Final gravity: 1.045 (11.2°Bx)

HONEY
3 lb. (1.36 kg) Yirsa Farms Hairy Vetch honey

WATER
96 fl. oz. (2.8 L) water

YEAST
Bootleg Biology Chardonnay

ADDITIONAL ITEMS
1.7 g Fermaid O, divided into four equal additions

PROCESS
Mix honey and water and cool must to pitching temperature. Pitch yeast and add pure O_2 for 30 seconds through a 0.5-micron stone (a stir whip on a drill works just as well and will keep you from over-oxygenating). Ferment at 60°F (16°C).

Add nutrients in four additions: (1) when active fermentation began, (2) at 1.100 SG (23.8°Bx), (3) at 1.086 SG (20.7°Bx), and (4) at 1.074 SG (18°Bx). The last of these is the ⅓ sugar break. You don't need to be quite this exact, as long as you stagger the additions. However, I find making additions by gravity preferable to staggering by the clock. A sluggish start or fast fermentation could cause you to unintentionally front-load or miss the points when your yeast needs some nitrogen. That said, a lot of great meadmakers do it by time intervals, so do what works best for you.

I like to keep my nutrients in small, sealable, plastic fridge containers. Then I just add a little distilled water, shake it up, and add that to the fermenter. You can do this with a plastic zip-top bag, too. You want to know your yeast's nitrogen requirements so you can adjust the amount of nutrient accordingly. You can usually find this information on the manufacturer's website.

If you degas, do so twice a day for the first week—make sure to do this before adding any nutrients or you'll have some great mead all over your floor. If you do a 1-gallon batch in a glass jug, I've found the yellow tops of the 1 lb. honey bears from the grocery store fit nicely on the top of the jug. Simply shake the fermenter and pop the top a few times to let out the CO_2.

Crash fermentation to 30°F (–1°C) at 1.045 (11.2°Bx). I usually have a ballpark final gravity target when I make a mead, and I start tasting when it reaches that mark. When I think it shows enough of the balance and flavor I want, I crash it. You could also dial down the original gravity to 1.066 (16.1°Bx), ferment dry, and then back-sweeten to your taste if that's the way you want to go.

Use potassium sulfate and potassium metabisulfite to stabilize and Super-Kleer KC to clarify. Let it sit about a month at 30°F (–1°C) until you can read a sheet of text through it and then bottle. I transfer to a keg and then use a bottling gun.

I keep this one still, but I think pétillant would be very nice, too. The yeast really makes the vanilla notes pop, and it has a very soft mouthfeel that keeps the body from feeling heavy or sticky. The flavor is pleasantly balanced, with enough acid to make this very drinkable. I really dig this honey and definitely recommend checking out Yirsa Farms. This could be a good platform for a very nice metheglin as well.

Enjoy!

resume. To do that, add 1 gram of potassium metabisulfite and 2 grams of potassium sorbate for a 1-gallon batch. Mix these with a little water and pour the mixture into the mead. Let this sit for 24 hours before you back-sweeten. Technically, this should be done based upon pH, but if you don't have the ability to measure that, I assure you the above calculations will be solid.

So, say you would like it to be 1.020 (semi-sweet) and the final gravity is 1.000:

$$1.020 - 1.000 = 0.020$$

That's 20 gravity points. Divide that by 35 (honey has 35 points per pound per gallon):

$$20 \text{ pts} \div 35 \text{ ppg} = 0.57 \text{ lb./gal.}$$

You probably have around 0.85 gallons that need to be sweetened. Multiply the gallons of mead you want sweetened by the ratio obtained above:

$$0.85 \text{ gal.} \times 0.57 \text{ lb./gal.} = 0.48 \text{ lb. of honey.}$$

Mix that with some RO water and add to the mead after you have stabilized it.

MATT WEIDE

Like all things in meadmaking, what you do depends on what you want to make—keep that in mind before you start anything. Light, carbonated traditional meads should be treated differently than sweet dessert traditional meads. Likewise, if you use a light hairy vetch honey, you may want to stay away from certain yeasts or oaks that will detract from the delicate flavors. Conversely, if you use avocado honey, heavy additions of oak can help build the flavor profile.

That said, I like to make sweet traditionals with large amounts or floral and fruit notes. I find that high gravities with lots of residual honey provide great mouthfeel. It turns out great, and additional fermentation tannins and oak are not needed, as these can distract from the final product. After fermentation, I may add acid or tannins, depending on taste. I use a "dual fine" clarifier and then use a filter down to 0.5 microns if time and motivation exist.

When it comes to tannins, oak additions, and acid additions, it always depends on the honey and what I'm going for. It is OK to blend honey, especially if you use one or more varieties that complement the base honey.

Annie Zipser, Amy Olsen, Andrew Luberto, Kevin Meintsma, Carvin Wilson, and Matt Weide are members of the American Mead Makers Association (AMMA) home governing committee.

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.

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 (density of wort or beer)

RIMS – recirculating infusion mash system

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

SG – specific gravity (wort/beer density)

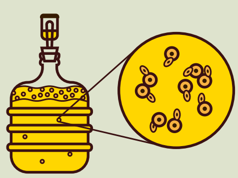
SMaSH – single malt and single hop

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

The Journey of Ryder's Castle Brewery est. 1971

By Norm Ryder

My beer brewing journey started in 1971 while I was attending a university summer school course. One of my study partners offered a beer her husband had made, and I was struck by its quality. I inquired if her husband would share his recipe, and thus my beer journey began.

One of his quirks was to cover primary fermenters with black garbage bags, which I do to this day! He claimed that light was the enemy of beer and, with results like his sample, who was I to ask questions?

This brewer was also a big fan of aging all beers one-and-a-half months to condition them. I was instructed to put a sleeping bag on newly bottled beers. This would allow them to carbonate faster if I kept the heat in, as fermentation is an exothermic heat reaction.

I once took a bartending course at a community college and the bartender teacher asked if any of us brewed beer. Reluctantly, I offered to bring in a sample of my wares, and after the class had tasted my beer, my instructor said it was the best homebrew he had ever tasted! Go figure. I was just copying the directions provided to me.

TIMELESS ADVICE

Here are a few things I did in the beginning. I still do them now.

As my brewery logo says, I brew with "Patience – Preparation – Pride."

When drinking beer, I always use a glass beer mug (usually a different shape for each specific type of beer) and always rinse it with cold water. This ritual helped keep the foam at bay in the early days before I learned how to pour beer properly.

Before consuming any beer, I always sip twice before deciding whether it is worthy of drinking or if I should consider discreetly watering the plants or pouring it down the drain.

I keep records of every batch, and I never drink while brewing.

I usually wait at least a month before I sample my wares.

I buy locally whenever possible, especially during the difficult times of COVID-19.

I started out using a big soup pot on the stove. Now my largest brew kettle is a 31-gallon monster for four-keg batches. Buy quality brewing gear when you decide to go to brew larger volumes.

I always keep a laundry sprayer filled with spring water or reverse osmosis water sitting near the brew kettles to knock down the foam at hot break.

I have always used one Campden tablet per 20 gallons (76 liters) to free chlorine or chloramine from city water.

I am still using my mother's bottle capper from the '50s. A club member 3D-printed a plastic washer to replace the hardened original rubber washer.

I always ask the server for a sample of any new selection I want to explore. They are very supportive when you tell them you are a brewer. Most of the time there is no charge, but it is prudent to tip well!

THE WISDOM OF HINDSIGHT

Here are a few lessons I've learned over the years.

Don't go it alone when you can join a homebrew club and shorten the learning curve. I belong to the True Grist Brewing Club.

Don't be shy about asking to talk to a head brewer. They seem to be eager to assist. Once a brewery owner gave me a personal tour (boots required) and told me he would answer all my questions but to keep in mind that certain things were proprietary procedures. I asked, "Does this mean if I ask you a question, and you refuse to answer, I am right?" After a stare back, he smiled and on we

Left: Melvico counter-pressure bottling machine and bottling station. *Center*: An insulated copper still head serves as the keezer tower. *Right*: Live-edge solid walnut bar. The insert on the bar is a special routed piece made from solid walnut.

Photos courtesy of Norm and Betty Ryder

went. I learned from this tour that 178°F (81°C) was safe for rinsing my mash, with 180°F (82°C) marking the red line not to exceed. When you lauter, stop the runoff when your refractometer or hydrometer reading drops below 1.008 to avoid astringency from the barley hulls. Brewers, when asked, seem very free about giving away yeast but never seem to have a container with a lid. Take a "yeast pail" with you so you can cash in on their generosity.

Clean as you go, and don't leave everything until after brew day!

I would never return to the cement laundry sink in my first house to clean my equipment. I now have a stainless-steel sink with two aprons; a built-in, designated, stainless-steel bottle washing station; and a spray head on a spring for washing yeast down the drain and cleaning kegs.

I started out washing bottles under the faucet in the laundry sink and then stacking them upside down in a milk crate set on an angle. Then I graduated to a bottle tree, and finally to two Fast Rack units that sit on the left apron of my sink beside the bottle washer.

Clean and sanitize everything you use for brewing. To date I have not experienced contamination in my beer.

I used to sanitize equipment with a purple-pink powder added to water and fragrance-free OxiClean. Today I clean my kettles and equipment with Straight-A Cleanser or PBW, and I sanitize everything with Star San or San Step.

When cleaning bottles, inspect the top of each bottle for cracks, and hold the bottle up to a light to check the bottom after washing, brushing, and sanitizing.

Always place bottle caps in sanitizer to wet the caps. This helps the bottles seal better so you do not experience under-carbonated bottles or leakers.

I used to use a bottling bucket to fill bottles. Now I use the holy grail of counter-pressure bottle fillers, a Melvico unit that I rebuilt.

Never bottle beer when it can be dispensed from a keg. Cleaning, filling, and labeling bottles is not fun!

I evolved from racking my beer with a vinyl hose using the splash method to aerate the wort, to aerating by stirring with a slotted spoon, to designing a stir rod, to finally using an oxygen cylinder and an aeration stone.

Racking canes, to me, belong in a museum. Use an auto-siphon.

I would never leave a standard burner to do its thing without adding the heat shields to get more heat where it needs to be and use much less propane.

Taking specific gravities using a graduated cylinder, a hydrometer, and lots of sanitizer has been replaced by a refractometer

"Clean as you go, and don't leave everything until after brew day!

Left: Sink area with washing station for bottles, kegs, and fermenters. *Center*: A grill cover protects the brew stand. *Right*: Malt storage center and homemade recipe planning table.

while mashing. So fast, so accurate (for me), and so little liquid lost.

I don't buy rolled malt anymore, as I have rebuilt a commercial rolling mill to quickly get results every time using a credit card (0.035") for setting the rollers. A farmer sold it to me, and I knew it was the one when the rollers were so sharp they cut my fingers when I squeezed them. The rollers had been re-knurled, and he had no idea what a treasure he had sitting in his haymow. I tore it down for cleaning and to see how the automatic feeder roller worked. Then I fabricated and installed a new hopper.

Do not use cheap grocery store thermometers. I now use a Thermoworks Thermapen Mk4 for almost instant results. This is so important when mashing!

I would never buy a brew kettle without a built-in thermowell. Temperature is so important for brewing, and built-in thermometers are as necessary to me as a stainless ball valve.

I would never lift kettles from the mash tun area to the propane burner again. I designed a lifter on wheels that works with a winch.

I would never want to return to uncontrolled fermentation. I made a ferment chamber using a controller to cool or heat my primary fermenters.

Diacetyl rests are the norm now.

I would never return to letting the wort pot sit to cool. I moved to placing the pot in ice or snow, then to a double helix coil immersion chiller, and now to a plate chiller.

I would never return to a regular garden hose. I now use a RV potable-water hose, which is usually white. I always run out some water before using it in my system to rinse the hose out.

No need to grow hops when you can buy them so cheap in bulk! I used to have a row of rhizomes with a watering system in my wood lot. I was paying $3.00 an ounce in those days. I now pay 10 to 16 dollars a pound for bulk hops.

Buying yeast in small units for testing a yeast is fine. It is more cost effective to buy a brick, zip lock the product, and share it with other brewers.

I used to read every possible textbook and brewing magazine to decide the next recipe. I now do the same, but I also use software (BeerSmith) to tweak my recipes. This way I can control my ABV, IBUs, and final gravity if I mash at proper temperatures.

I used to label my craft beer with a magic marker on the bottle caps. Then I purchased printed labels that were expensive and difficult to remove. I next tried to print simple labels with my color inkjet printer. I now use laser-printed labels with my brewery logo on it. A glue stick with a swipe on each side of the label attaches my labels after I dry the condensation off the bottles. I printed more than 2,000 labels, six per page, in 2020.

I would never brew just one type of beer like I did in 1971. In 2020 I made 29 different recipes. A few were repeats.

I have enjoyed my journey brewing from grain to glass and encourage everyone reading this to enjoy the journey. If you track everything and have sufficient patience you will craft super beer!

"Patience – Preparation – Pride" is my personal motto! Brew on!

Norm Ryder lives in Ontario, Canada, and has been homebrewing for 50 years.

Left: 1 horsepower Champion HD 8 rolling mill with 5"×8" knurled rollers and powered auger feeder.
Center: Homemade red lift with plate chiller.
Right: Mash tun and hot liquor tank.

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COUNTDOWN BREWING

"May you live in interesting times" is an old curse. The current interesting times in which we live make me glad that my wife and I live in a rural area with no TV reception and that I'm too cheap to spring for cable. I get all the news I can handle on the internet, and it's easier than you'd think to set the tablet aside and put a funny DVD in the player if you start to feel overwhelmed. I recommend *The IT Crowd*.

I can only handle so much mindless entertainment, and I need something more to distract me. Something more? Hmm… This is a homebrewing magazine, so you know where I'm going but not how I'll get there.

I want to brew good beer, but I also want to make it as easy on my limited multitasking capabilities as I can—hard as I try, I can't get the current pandemonium completely out of my mind. And, at my age, I need to conserve as much energy as possible.

Seven years ago, I came up with the KISSOFF plan for recipe formulation: "Keep It Simple, Sir, of Fermentation Fanaticism," which is three grains or less, two hops or fewer, and one yeast. Having gotten tired of the neighborhood kids pointing; yelling, "Kiss off!"; and laughing when I walked by, I renamed it Countdown Brewing. The only kid who doesn't point and laugh is the paper boy, and I have to tip him $10 a week to keep the smirk off his face.

Here's my take on how to simplify the entire process.

WATER

I once used a Brita filter, which was simple, but letting water slowly work its way through the filter was time consuming, and I had to remember to refill the pitcher every 20 minutes or so. Finely crushing and vigorously mixing Campden tablets into the brewing water was simpler and quicker, but not the simplest. Plus, I rigorously try to avoid anything described as vigorous.

Luckily for me, my local water company uses chlorine and not chloramines, so all that's necessary is to pour water into a bucket and let it sit uncovered the day before brewing. It may not match the water profile of any famous brewing region, but it's simple and easy and makes good beer.

HOPS

The simplest thing to do is just chuck them in loose, cones and pellets alike. My personal preference is for pellets, although either form can cause problems later in the process depending on your individual system. If I'm brewing something with a lot of hops, then I bag them.

YEAST

It would take several Last Drop columns to cover the debates over dry versus liquid yeasts (dry for me) and whether to rehydrate or not (not for me). Liquid obviously gets the nod for variety, but it usually requires a starter, which is simple but still time consuming. You can't beat just tossing in a pack of dry yeast. The only thing that would be simpler is an uncovered bucket of wort under an open window.

MALT OR EXTRACT

Even all-extract brewers can Countdown. Mix some Pilsner, Vienna, and Munich extracts for an excellent Oktoberfest beer.

For Pilsner, Kölsch, helles, and other light-colored beers, I formulate a recipe with Pilsner malt or two-row, light crystal malt (10–20°L), and a touch of Munich or Vienna. For amber lager, I start with Pilsner malt and then add some medium crystal (20–40°L) and character malt like Victory or melanoidin.

Pale and amber ales call for pale ale malt, of course, and a touch of some medium to dark crystal (40–80°L) along with something like honey malt or, my new favorite, Great Western Brūmalt.

For dark beers, I first decide just how dark I want to go. I use Pilsner or two-row malt as the base for brown ales and Munich malt for black beers. Then I decide on medium or dark crystal (if used), medium roast malt, and/or dark roast malt. I like Briess Extra Special Malt and Baird's Dark Crystal Malt, which give aspects of of caramel, toffee, and roast flavors all in one.

SIMPLIFY, SIMPLIFY, SIMPLIFY (AND ENJOY)

Even if you can block out the upsetting events going on in the world when you brew, Countdown Brewing can simplify your brew day and ease the strain on your wallet by reducing the number of grains and hops you need to buy. A great place to start is my Countdown Brewing version of Black is Beautiful stout on page 9 of this issue of *Zymurgy*.

***Steve Ruch lives in Fort Wayne, Ind., and is a regular contributor to* Zymurgy.**

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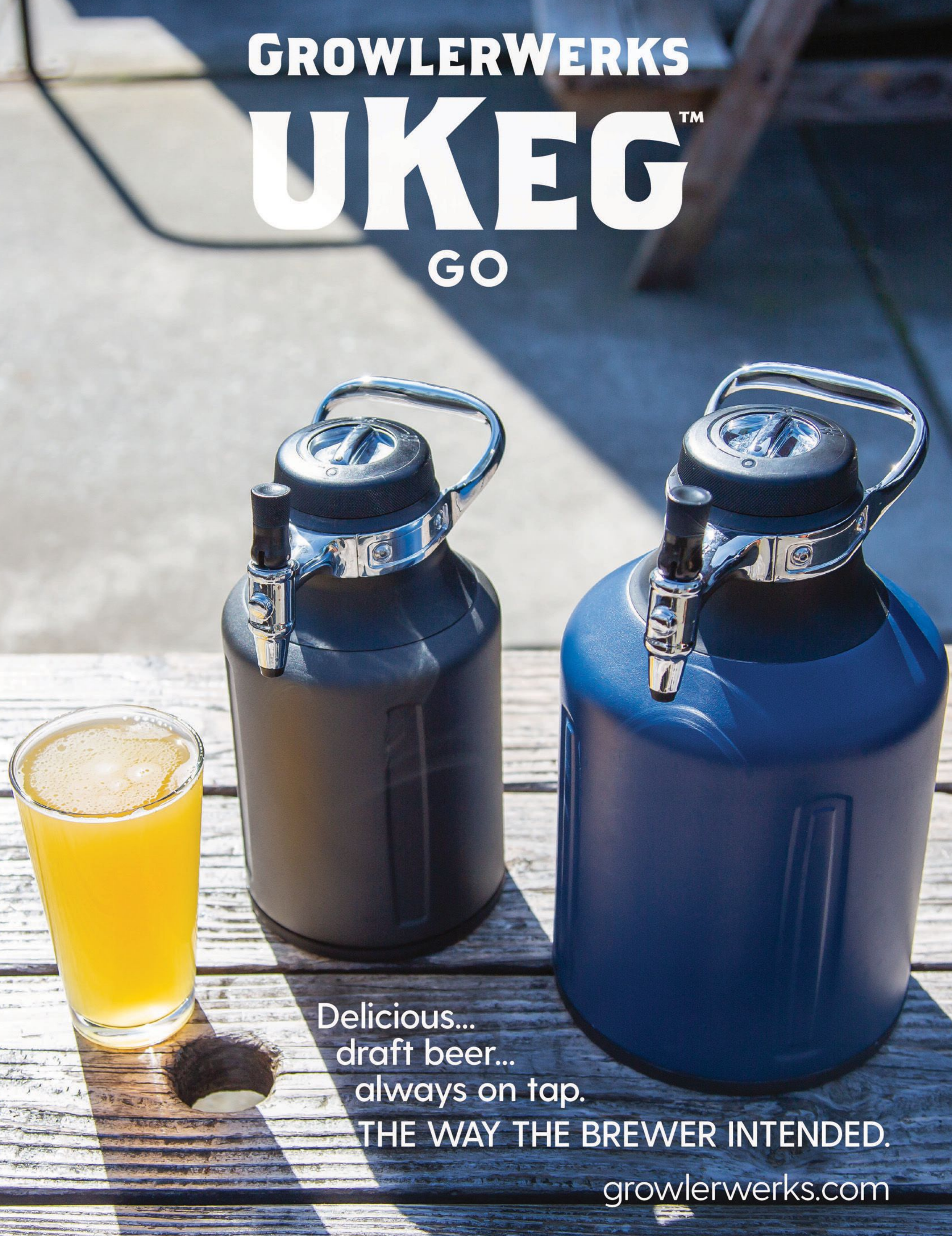
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