TOP CROP

the science of modern brewing // an omega yeast project // analog vol. 001

RECIPE INSIDE

Mega Omega Hazy DIPA

A hazy double IPA collab by WeldWerks with Omega Yeast

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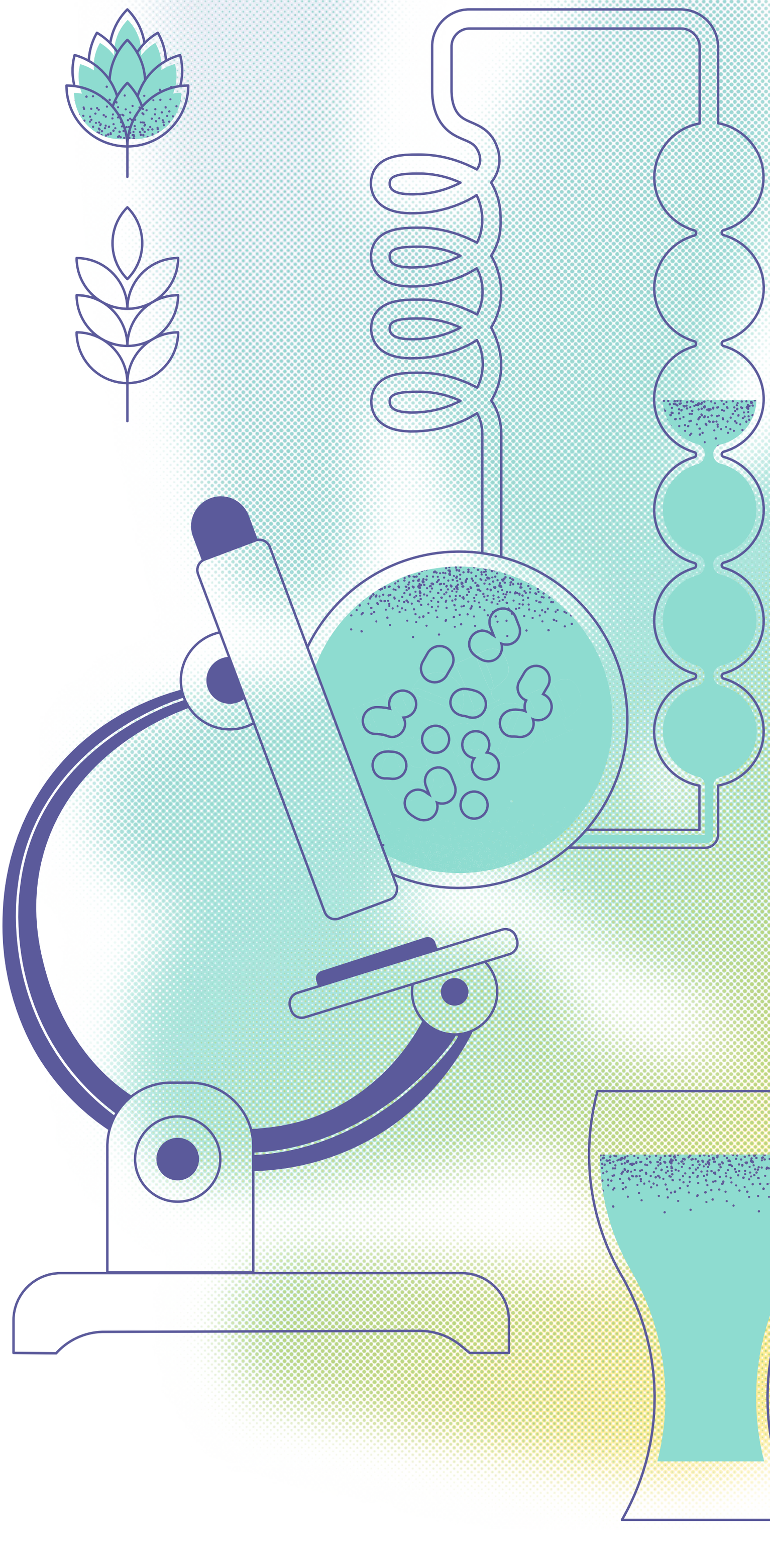

Crazy for Hazy

The last two decades have witnessed a sea change in brewer and beer consumer perception of haze. In the US especially, craft beer drinkers have come to appreciate, and even expect to see, haze in beer. There is evidence that haze contributes to the aromatic qualities of hoppy beer by solubilizing hydrophobic components of hops. In some beer cultures, however, haze is viewed as the enemy.

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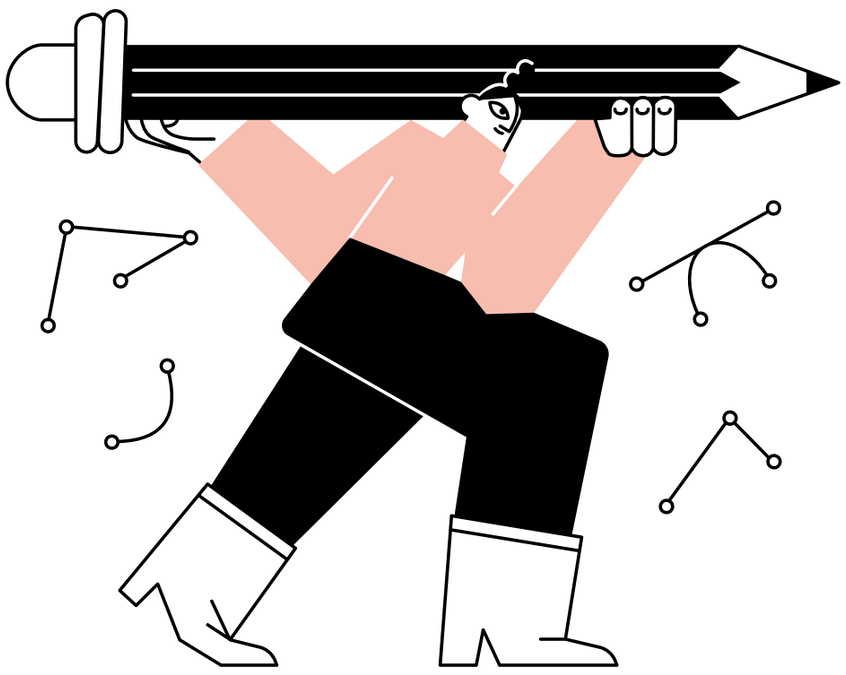
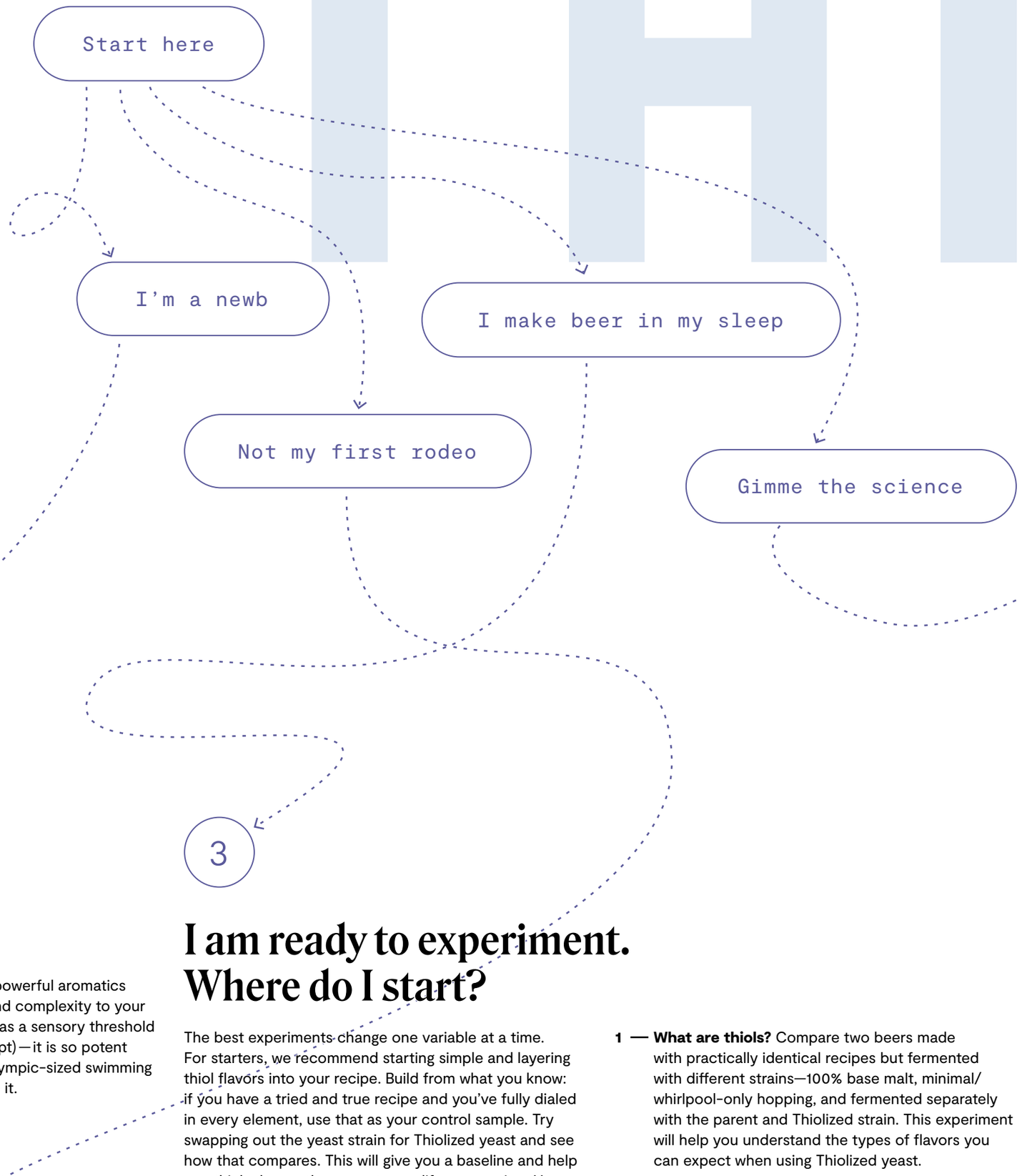
WHAT'S UP WITH THIOLS





What are thiols?

Thiols are intense aroma compounds that evoke grapefruit, passion fruit, and guava and are found in hops and a variety of tropical fruits. Thiols are also responsible for the roasty aromas of coffee, the skunky aroma of cannabis, and that classic *je ne sais quoi* punchiness that makes the Marlborough region of New Zealand famous for their sauvignon blanc.

Thiols, like esters and phenols, are powerful aromatics that can contribute depth, flavor, and complexity to your beers. One such compound, 3SH, has a sensory threshold of 60ng/L, or 60 parts per trillion (ppt)—it is so potent that if it were just one drop in an Olympic-sized swimming pool, you would be able to perceive it.

Where do thiols come from?

Thiols exist in two forms—free forms, which are highly aromatic and volatile, and precursor forms (also referred to as bound thiols).

Free thiols can be found in some varieties of hops, like Nelson Sauvin, Citra, Mosaic, and Simcoe, to name a few. This means that when you use hops like these, it's highly likely that the finished beer will have perceptible tropical fruit-like aromas.

The precursor forms are non-aromatic and require yeast with carbon-sulfur lyase biotransformation activity to release them. Some hops have thiol precursors, and barley is highly abundant in precursors. Thiolized yeast acts as the key to unlocking these precursors from their bound form and releasing them into beer as aromatic thiols.

Malt terroir and thiol potential
While the research is still in progress, we have seen positive results when brewing with grain bills that primarily employ malted barley. Through our experimentation, we have found that barley malts almost certainly contain high amounts of thiol precursor, where malted wheat and oats have substantially less.

The actual amount of thiol precursor varies among different barley varieties as well as the potential for malting practices to impact thiol precursors. Anecdotally, lesser-kilned malts have provided more thiol output. This isn't a strict observation as our research has found that some lightly kilned Munich malts can still provide the same precursor amounts as a pilsner malt.

Run sensory tests and take note of thiol intensities when testing out new malt suppliers or working with local maltsters to cultivate your own sense of thiol precursors. We're hopeful that brewers and maltsters (and yeast labs, of course!) will continue to experiment with different regional grains and discover the full picture.

Mash hopping
While it may seem counterintuitive, adding hops to the mash is a great way to increase the level of thiols in the finished beer when that's the flavor profile you are aiming for. We ran trials using Cascade hops in the mash and found a 20% increase in 3SH levels when fermenting with Cosmic Punch, the Thiolized version of British V that uses the *IRC7* gene.*

While some hops are more rich in precursors than others, mash hopping is a reliable way to form a larger pool of thiol precursors. We recommend lower alpha acid hops to avoid over-bittering (assume 30% of the IBU levels that you would get with a beginning of boil addition) and to avoid expensive aroma hops because much of the other volatile hop aroma compounds will be lost in the boil and beginning of fermentation.

*Note: *patB* strains (Star Party, Helio Gazer, Lunar Crush) generate intense thiols on their own from barley malt— we haven't found it necessary to mash hop when using these strains.

Precursor-rich products
Apart from malt and hops, there are other products available to brewers that are replete with thiol precursors. Many thiol aromas remind us of tropical fruit because those same compounds are found in the fruit themselves, so try blending in mango, passion fruit, pineapple, guava, etc. to see how those flavors meld with your recipe when using Thiolized yeast. (See "Thiol Sensory")

The beer world's relationship with thiols is just beginning to truly flourish, but the wine industry has a long and storied history of studying thiols. Decades of wine research have shown that the types and amounts of thiol compounds vary by grape variety, growing region, and cultivation practices, and we know from recent research in beer that this plays out similarly with hops and barley. We have experimented with different varieties of grape juices and grape skin-derived products (like Phantasm®) when brewing beer and found thiol compounds to reach a stronger aroma intensity when used in conjunction with Thiolized yeast strains.

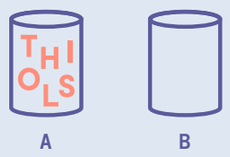
I am ready to experiment. Where do I start?

The best experiments change one variable at a time. For starters, we recommend starting simple and layering thiol flavors into your recipe. Build from what you know: if you have a tried and true recipe and you've fully dialed in every element, use that as your control sample. Try swapping out the yeast strain for Thiolized yeast and see how that compares. This will give you a baseline and help you think about other ways to modify your recipe. Use the tips and guidelines below to enhance or integrate thiols into your beer.

These three experiments are designed to help you understand a few key concepts regarding thiols:

Three experiments to understand thiols

1 What are thiols?

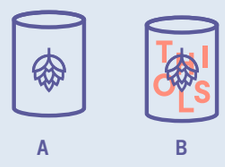


> 100% base malt
A. Thiolized strain (e.g. Star Party)
B. Non thiol strain (e.g. Chico)

2 How does dry hopping affect thiol intensity?

> 100% base malt
> Thiolzed strain (e.g. Star Party)
A. No dry hops
B. Dry hops

3 How do thiols affect the perception of hops/hop profile?



> 100% base malt
> Dry hops
A. Non-thiol strain (e.g. Chico)
B. Thiol strain (e.g. Star Party)

1 — **What are thiols?** Compare two beers made with practically identical recipes but fermented with different strains—100% base malt, minimal/whirlpool-only hopping, and fermented separately with the parent and Thiolized strain. This experiment will help you understand the types of flavors you can expect when using Thiolized yeast.

2 — **How does dry hopping affect thiol intensity?** Compare two beers made with the same grain bill and fermented with the same Thiolized yeast strain, but with only one of them dry hopped (we recommend starting with 2 lb/bbl). This experiment will demonstrate the way that dry hopping affects the intensity of thiols in the finished beer.

3 — **How do thiols affect the perception of the dry hop profile?** Compare two dry-hopped beers fermented with the parent and Thiolized strain (for best results use the same strains you used in experiment #1). This will help you understand how thiols affect the perception of the hop profile when expressed in dry-hopped beer.

Make sure to compare Thiolized yeast with the corresponding parent strain: if you want to test out Cosmic Punch or Helio Gazer, run trials side by side with British V; compare Star Party with Chico, Lunar Crush with Mexican Lager.

When using Thiolized yeast strains in a recipe, remember that thiols are the most potent component. Consider how these intense thiol flavors will work together with the other parts of your recipe.

Of the four strains, Cosmic Punch has the least intense thiol output while still generating thiol levels approximately ten times above sensory threshold. The other three strains (Helio Gazer, Star Party, and Lunar Crush) generate even higher thiol levels roughly 250–300 times above sensory threshold because they use a different thiol-freeing enzyme—more on that in the next section.

Additionally, blending Thiolized strains with their non-Thiolized counterparts will result in lower thiol output proportional to the blend (e.g., 50% Thiolized yeast in the blend will result in about half the thiol output). Starting with blending is a great way to fine-tune your beer to achieve your ideal level of thiols.

Thiols, like esters and phenols, are powerful aromatics that can contribute depth, flavor, and complexity to your beers.

4

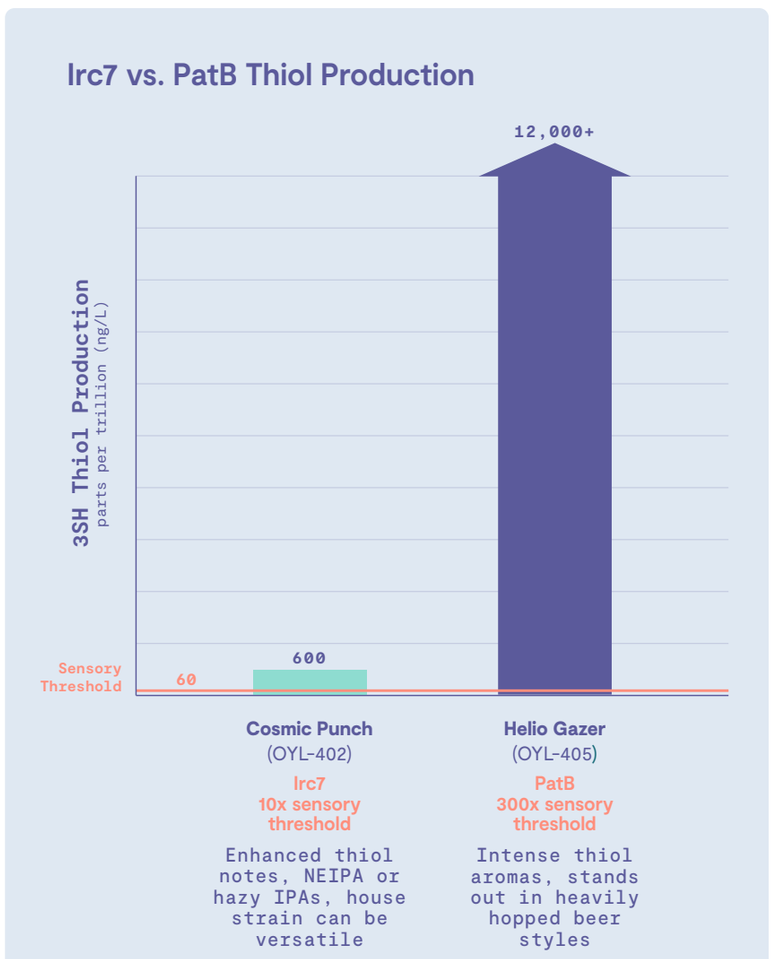
I'm here for the science.

The four Thiolized strains leverage enzymes to make thiol aromas pop. There are two genes at work here: *IRC7* and *patB*.

IRC7 is a gene derived from yeast that encodes an enzyme that frees thiols from their precursor form. Many brewing strains don't have a functional *IRC7* gene, and those that do never see the gene expressed due to the high nitrogen levels found in wort that keep the gene turned off. Using CRISPR/Cas9, we added the activated version of *IRC7* into British V, creating Cosmic Punch.

patB serves a similar function to *IRC7*, but *patB* is derived from *S. hominis*, which commonly occurs on human skin as part of our natural microbiome that protects us from pathogens. Another difference is that *patB* is even more active and specific than *IRC7*, so its thiol output is more intense than yeast using *IRC7*. By adding *patB* to our British V, Chico, and Mexican Lager strains, we created Helio Gazer, Star Party, and Lunar Crush.

Scan here for a deep dive into how we developed the Thiolized strains



THIOL SENSORY

Beyond Beer: Thiol Sensory Training

While many beer enthusiasts can easily identify ester- and phenol-driven flavors, thiols haven't historically commanded quite as much attention as other fermentation flavors.

The best way to learn flavors is to experience them firsthand—if you've never tasted a banana, you'd have no reference point when tasting classic hefeweizens! The same goes for thiols. We can talk at length about typical thiol aromas—guava, grapefruit, passion fruit—but without ever having experienced these flavors on their own and in combination, it can be difficult to pinpoint them in beer. We've set up a tasting activity that you can run through on your own or with your brewery team or homebrew club to get a better grasp on thiol flavors.

Polyfunctional Thiol	Sensory
4MSP (4MMP)	box tree, black currant
3SHA (3MHA)	passion fruit
3S4MPol	grapefruit, rhubarb
3SH (3MH)	grapefruit, passion fruit

Materials:

- New Zealand sauvignon blanc wine
- As many of the following as you can find: guava juice, passion fruit juice, grapefruit juice (substitute flavored sodas if juice is not available)
- Pale lager
- Dry-hopped IPA

Tasting procedure:

1 — First, familiarize yourself with each of the fruit juices. These fruit flavors are typical of what you should expect when tasting thiol-forward beers.
2 — Taste the New Zealand sauvignon blanc. These wines are the prototype for the flavor profile many brewers are aiming for.
3 — Now taste through the beers on their own: first the pale lager, then the dry-hopped IPA. Take notes on the flavor profile, focusing on the ester and hop profiles (or lack thereof).
4 — Finally, the fun part: begin blending! Mix a bit of the different fruit juices together to see how those flavors meld and interact when combined.
5 — Blend a bit of fruit juice in with the beers. Take note of how the fruit flavors interact with the lager, and how the hop profile is enhanced or diminished as these blends come together.
6 — Repeat with various combinations to see how these flavor intensities change.

RECIPE

Mega Omega Hazy DIPA

A hazy double IPA collab by WeldWerks with Omega Yeast

WeldWerks and **Omega Yeast** partnered up on a collab mission to find the Thiolized sweet spot for the Mega Omega hazy double IPA. Wanting a more expressive thiol profile than they got when experimenting with Cosmic Punch, WeldWerks set out to harness Helio Gazer's thiol-blast potential for huge passion fruit, dank guava, and fresh citrus notes, with a soft, pillowy landing. Their carefully selected grist, hops, and hop timing balanced haze stabilization with a ton of thiol enabling.

Since adjuncts have little to no thiol precursor, WeldWerks' high-protein grist bill for hazies, which includes white wheat, flaked wheat and flaked oats, served haze and mouthfeel, while the remaining amounts of pilsner and pale ale base malts added good amounts of precursor for Helio Gazer to convert. The hop character of experimental New Zealand hop product Mega Motueka, containing Phantasm, was elevated by thiols, while it also added more precursor to help create them. Hot side hops went in an extended whirlpool at 194°F to keep the aromatic potential high and bitterness low. Then, dry hopping brought dominant thiols into balance with hop character.

VITAL STATISTICS

Batch size 18 bbl
Boil time 75 min
IBUs 16.9
OG 20.552°P
FG 5.762°P
ABV 8.23%

RAW MATERIALS

Yeast
Helio Gazer

Mega Motueka
Whirlpool: 16.5 lb
Dry Hop 1: 11 lb
Dry Hop 2: 16.5 lb

Motueka
Whirlpool: 11 lb
Dry Hop 1: 5.5 lb
Dry Hop 2: 11 lb

Lotus
Dry Hop 1: 5.5 lb
Dry Hop 2: 11 lb

Pilsner (Great Western)
39.5%

Pale Ale Malt, Northwestern (Great Western)
26.3%

Oats, Flaked
9.9%

White Wheat Malt (Great Western)
7.2%

Wheat, Flaked
6.6%

Acidulated (Weyermann)
3.6%

Dextrin (Proximity)
3.6%

Bioglucanase GB

PROCESS

1 — Hot side: add hops during an extended whirlpool at 194°F.
2 — Pitch Helio Gazer at 68°F and ferment for 14 days.
3 — Mega Motueka: 3.6 AA / 16.5 lb / 20 mins left in WP. Motueka: 7AA / 11 lb / 20 mins left in WP.
4 — Dry Hop #1—9 days before transfer. Mega Motueka: 11 lb // Motueka 5.5 lb / Lotus 5.5 lb.
5 — Dry Hop #2—4 days before transfer. Mega Motueka: 16.5 lb // Motueka 11 lb / Lotus 11 lb.

DIACETYL CONTROL

The Legend of Popcorn Lung

In the 1990s, eight former microwave popcorn factory workers were diagnosed with a rare and serious lung disease known as bronchiolitis obliterans, which came to be referred to as “popcorn lung.” Half of the patients had lung damage so extensive that they were put on lung transplant waiting lists. Ultimately, physicians determined that cumulative exposure to diacetyl vapors was the cause of the lung damage. In the early 2000s, the first case of popcorn lung in a consumer was identified and subsequently some microwave popcorn brands said they would reformulate their recipes in order to stop using diacetyl as a flavoring.

Fear not, drinking beer with diacetyl won’t hurt you—you’d have to consume pure, undiluted diacetyl at high rates for a very long time to get popcorn lung.

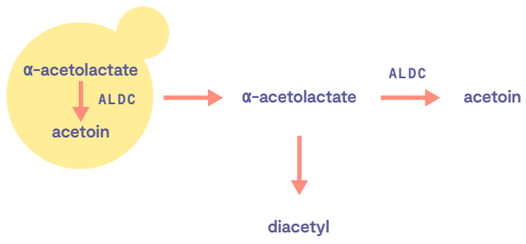
Diacetyl—a quick runthrough on everybody’s favorite (or perhaps most feared) VDK

Diacetyl is an organic compound in a class of vicinal diketones (VDKs), and is a natural byproduct of fermentation. When yeast get to work synthesizing the amino acids valine and leucine they produce an intermediate molecule called alpha-acetolactate. The conversion of this intermediate to valine requires a few more steps, one of which is a relatively slower process. Excess alpha-acetolactate builds up and some is excreted by the cell into the surrounding beer where it spontaneously reacts to make diacetyl. However, this isn’t a problem because healthy cells can reabsorb and convert that diacetyl to a flavorless compound called 2,3-butanediol, and your sensory panel (and those atop a bar stool) will be none the wiser.

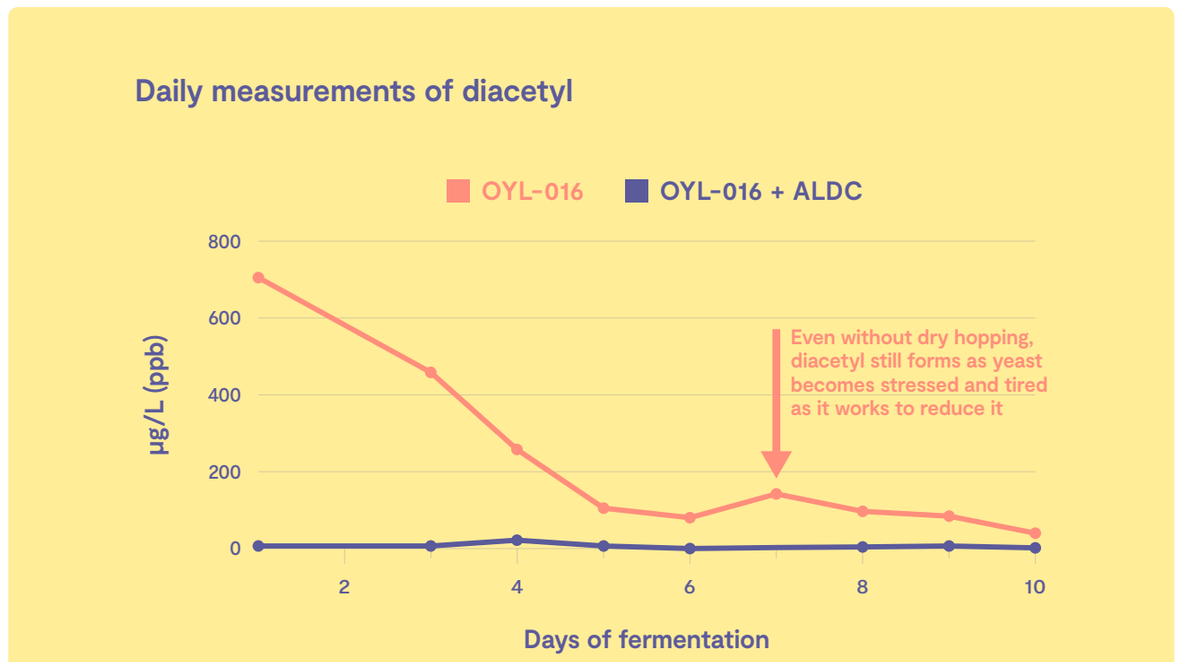
In a perfect world, this process would run smoothly and efficiently every time. However, low free amino nitrogen (FAN) levels in wort will make yeast cells work harder, as will underpitching. Poorly aerated wort and low ATP levels can also reduce efficiency, and higher fermentation temperatures will speed up all these processes and make it so the yeast cells can’t reabsorb diacetyl quite as readily. So in short: give your yeast the nutrients it needs and give it time and a cozy temperature range to do its thing. Happy, healthy yeast can clean up after itself.

Controlling Diacetyl with ALDC and Yeast Selection

ALDC (alpha-acetolactate decarboxylase) is an enzyme that breaks down alpha-acetolactate, the precursor for diacetyl within the yeast cell and converts it into acetoin, a flavorless compound. You may be familiar with ALDC, as many brewers use it at the start of fermentation to help avoid the formation of diacetyl, which saves on tank time. However, ALDC is very pH-sensitive and can be less effective as the pH level drops during fermentation (typically below 5), meaning that it might not be super helpful in the case of hop creep. ALDC is a proactive, rather than reactive, solution; it won't help you clean up diacetyl once it's already in the beer.



ALDC in cell converts α-acetolactate directly to acetoin; without ALDC α-acetolactate is excreted and becomes diacetyl OR with exogenous ALDC, it becomes acetoin in the beer.



There is existing research on having ALDC expressed within the yeast cell. When ALDC is expressed in the cell it converts alpha-acetolactate to acetoin directly within the cell, therefore preventing alpha-acetolactate from building up and being excreted into the beer where it will turn into diacetyl. Another bonus to ALDC activity within the cell is that it will continue working even during later stages of fermentation, which can help mitigate hop creep. These sorts of strains are already in testing with our brewing partners and coming soon to Omega Yeast's commercial catalog—stay tuned for more updates.

Why use ALDC strains as opposed to adding the enzyme? Some brewers may see cellular-level ALDC as "lazy" brewing, but we see it as a time- and cost-saving innovation. Even with great yeast management, having ALDC expressed in the cell increases efficiency in the brewery by reducing tank time. Without the need for a lengthy diacetyl rest, your beer can be turned around faster and with more confidence that diacetyl will be far less likely to form after packaging. Plus, breweries can save additional costs by not buying exogenous ALDC for strains that are not diacetyl prone.

Should every strain receive the ALDC treatment? In short, no. Some strains are less prone to hop creep-induced diacetyl formation, like British V (OYL-011). However, a handful of strains have exhibited an increased presence of diacetyl in their fermentations and are better candidates for this modification. Again, diacetyl can be avoided and kept to a bare minimum with healthy yeast and properly managed fermentation, but by including this ALDC activity at a cellular level brewers can have more predictable outcomes and save time on troubleshooting and problem solving.

Is diacetyl EVER okay? Here's the thing: diacetyl can be pretty controversial! Some brewers have an incredibly low tolerance for diacetyl, going to great pains to remove every possible trace of it from their beer. Others don't mind it so much, and may even prefer a touch of it in certain styles. Some traditional Czech lagers and English ales will have a low level of diacetyl, such that most drinkers wouldn't necessarily consider the beers to be buttery, but having a pleasantly round mouthfeel and a hint of sweetness. Brewing these styles with zero tolerance for diacetyl would effectively change their flavor profiles and make them taste different from the classics.

Sometimes the presence of diacetyl can indicate bigger issues. Apart from stressed yeast or mismanaged fermentation, bacterial contamination is often another source of diacetyl. This can occur in the brewery when equipment like hoses, clamps, and even kegs are not being sanitized properly. Draft lines are another tight spot where bacteria like *Pediococcus* can really thrive. As a brewer, there isn't often much you can do about draft line cleaning (unless it's in your own taproom), but you can equip yourself with the knowledge that regularly cleaned draft lines (biweekly with a caustic solution and quarterly with an acid solution) keep your beer flowing and tasting great.

Some brewers may see cellular-level ALDC as "lazy" brewing, but we see it as a time- and cost-saving innovation.

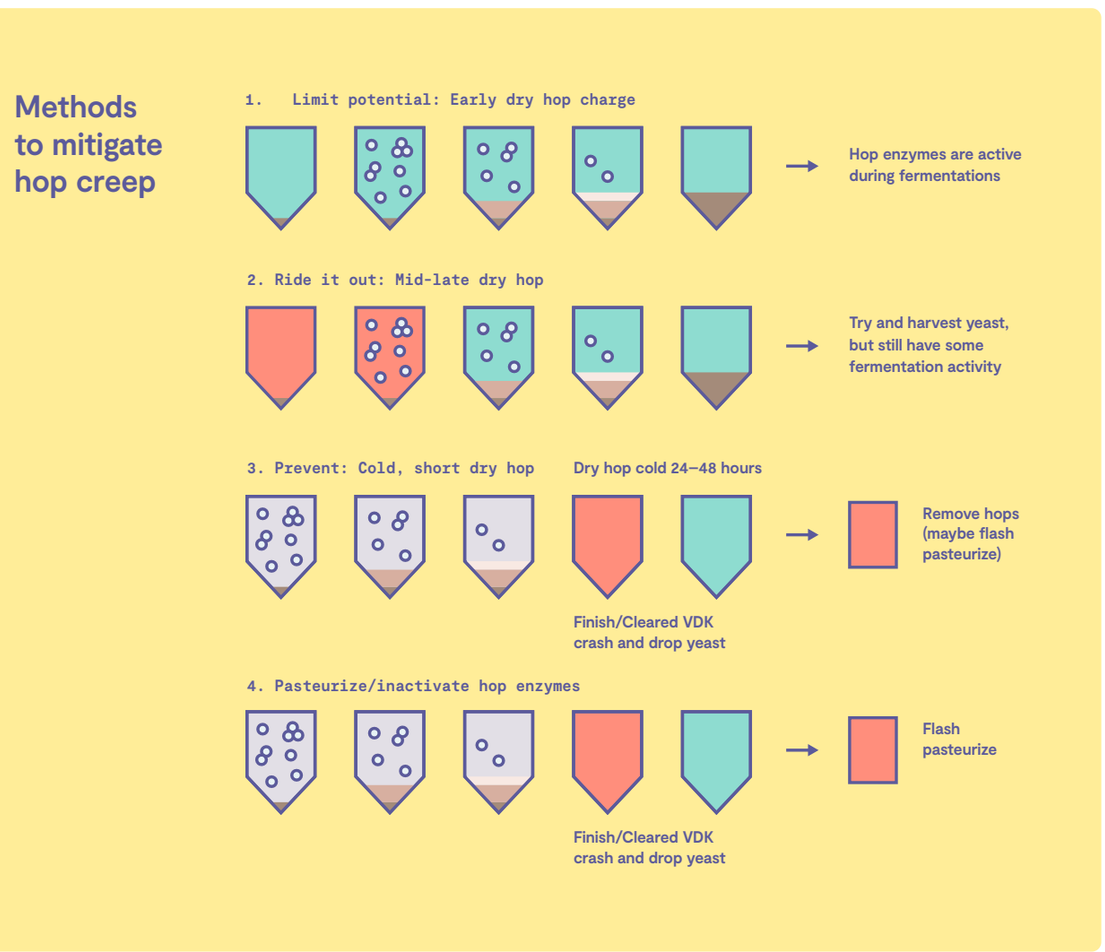
SENSORY

Tasters usually perceive diacetyl as butterscotch or a generally buttery aroma, reminiscent of movie theater popcorn. Some tasters claim that diacetyl reminds them of warm or sour milk. One important thing to note is that some tasters may be anosmic to diacetyl, meaning they can't smell or taste the buttery notes described by others. Fortunately, diacetyl can often manifest as a slick or oily sensation on the palate, giving tasters an additional component to look out for when tasting.

Diacetyl & Hop Creep

When dry hopping is performed late- or post fermentation, the yeast are no longer in an ideal environment like they were when the wort was fresh and sweet. At the end of fermentation the beer lacks nitrogen and sugars, so fermentation slows down and will essentially stop once terminal gravity is reached. The hops introduce enzymes, which liberate more fermentable sugars. The yeast's metabolism kicks back into gear to consume the sugar, but they still don't have all the nutrients they need. Consequently the yeast start to manufacture their own amino acids, including valine and leucine, and once again diacetyl is produced. But with their metabolism slowed by a nutrient-depleted and stressful environment of finished beer, the reabsorption of diacetyl is much slower, and aroma-active diacetyl will remain in the beer, much to the detriment of the drinker and your QA panel.

Read more about the great puzzle that is hop creep



Hop creep takeaways

- Hop creep happens and it is manageable. You can find creative ways to mitigate it while still getting the benefits of yeast repitching, flavor, and haze.
- Think about changing your yeast strain and/or approach if you continue to see stubborn diacetyl or trailing fermentations in your tanks.
- Think about what you are asking of your yeast: "I'm on my last legs doing my best to clean up your beer, and now you go and stress me out with a dry hop." - Your Beloved Chico

Methods to mitigate hop creep

1 — Limit the potential
- Use hops with high diastase activity in the whirlpool, and low diastase activity for the dry hop (hop suppliers may have this info)
- Target more conversion in the mash—don't leave behind future snacks for enzymes to chomp on
- An early charge of dry hop can minimize creep potential of later additions

2 — Ride it out
- Time your dry hop for when the yeast is still active (pre-diacetyl rest)

3 — Prevent it with a cold, short dry hop
- Get through fermentation, crash cool, dry hop for a short contact time
- Can be a little risky if enzymes have a chance to convert later in warm storage

4 — Pasteurize/inactivate hop enzymes
- Direct inactivation of hops (e.g., sous vide hop trials)
- Very low pasteurization unit targets with a flash pasteurizer can be used to inactivate enzymes

CRAZY FOR HAZY

Haze and its Sources

The last two decades have witnessed a sea change in brewer and beer consumer perception of haze. In the US especially, craft beer drinkers have come to appreciate and even expect to see haze in beer. There is even evidence that haze contributes to the aromatic qualities of hoppy beer by solubilizing hydrophobic components of hops. In some beer cultures, however, haze is viewed as the enemy.

For example, patrons in English pubs have been known to send back a cloudy pint drawn from a cask, and German lager brewers often strive to achieve brilliant clarity without filtration for most of their beers.

Much of our understanding of beer haze revolves around chill haze and permanent haze:

Chill haze is a haze that forms at colder temperatures when malt proteins and malt/hop polyphenols interact loosely (hydrophobic interactions, hydrogen bonding, Van der Waals forces). This type of haze is reversible.

Permanent haze occurs when malt proteins and malt and/or hop polyphenols become covalently bonded. This non-reversible haze occurs over extended aging periods or can be forced with repeated cycles of warming and cooling.

So now that we are looking closely at haze, rather than trying to excise it, how do we embrace and perfect it? First, some basics:

What exactly is haze?
Effectively, haze is turbidity (see Figure 1). Turbidity is caused by small particles suspended in a medium that obstruct light, similar to fog or smoke in the air. Based on the concentration and size of the particles, the resulting haze can vary from nearly clear to completely opaque. Haze isn't just a concept—it can be measured. We typically expect no turbidity in our tap water, but something rather opaque like milk would measure a high level of turbidity. Nephelometric turbidity units, or NTUs, help scientists determine objectively the amount of light scattered by these particles. While the measurement may not be all that exciting for beer drinkers, it can help researchers understand how various changes in the brewing process affect turbidity.

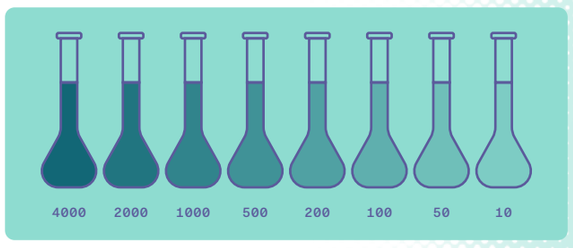


Figure 1. More NTU means more haze, as demonstrated in the image above.

Haze in beer
When we talk about the haze in hazy IPA, we're referring to something closer to the permanent variety—that milky haze that seems to magically appear when buckets of hops are added to the fermentor during fermentation. One popular belief is that this type of beer haze occurs as a result of interactions between malt proteins and hop polyphenols. It's truly a "Goldilocks" scenario: if the protein-polyphenol complexes become too large, you get colloidal instability, or what look like fish food flakes swirling around, creating a snow globe effect and resulting in sludge at the bottom of the can. If the protein-polyphenol complexes are too small, they won't obstruct light and the haze will be minimal.

Brewers have explored all sorts of methods for manipulating haze, and much of this focus has been on what can be contributed from malt and hops. For malt, increasing protein content by using wheat and other high-protein adjuncts, as well as beta-glucan content from oats, have proved to be a part of the haze equation. Dry hopping is another piece, with the leading theory being that hop polyphenols play an important role in haze development, which is one reason why we tend to associate styles like NEIPAs with haze.

Yeast & Haze

There's lots of talk about how ingredients and process can affect haze, but we want to focus on how yeast can affect haze. Our go-to terminology includes "haze positive" to signify strains that could be used to promote haze in a beer recipe and "haze neutral" for strains that don't seem to have much, if any, effect on haze. We got here by running experiments using various strains and subjecting samples to dry hopping at different intervals: knockout, day 1, day 2, and so on all the way up to day 7.

Key points from these experiments:

- **Earlier dry hop timing** could be a method of removing haze. Flasks with knockout dry hops tended to clear up the sample (and this is true for both haze positive and haze neutral strains).
- **Mid to late dry hopping** promotes haze, in combination with haze-positive strains. Certain varieties of hops create more haze than others (Galaxy, for example).
- **Haze is not related to flocculation** (there are examples of low flocculating yeast that are haze positive and some that are haze neutral). In other words, the haze in hazy IPA is not a result of yeast in suspension.
- **More dry hops means more haze.** The amount of haze was correlated with the size of the dry hop load.

Consistent performance as "haze positive" strains:

- **British Ale I**
- **British Ale V**
- **East Coast Ale**
- **Hefeweizen Ale I**
- **Irish Ale**
- **Kolsch I**
- **Kolsch II**
- **Voss Kveik**
- **Scottish Ale**
- **West Coast Ale II**
- **West Coast Ale III**

Need a little coaxing ("haze neutral" strains). These strains will require you to work a bit harder to get stable haze:

- **Bayern Lager**
- **British Ale VIII**
- **DIPA Ale (Conan)**
- **French Saison**
- **German Lager I**
- **Lutra Kveik**
- **Tropical IPA**
- **West Coast Ale I (Chico)**

Late fermentation dry hopping will definitely help promote haze. Timing your dry hop to be at the tail end of fermentation—when the yeast is still pretty active—can also be a strategy for mitigating hop creep.

We're still working to uncover all the secrets behind hazy beer—sign up for updates from Top Crop to get the news as it breaks

/ MISCONCEPTIONS

1 — **You have to use a low-flocculating yeast to achieve hazy beer.** Not true. Our research indicates that flocculation *does not correlate* with haze stability. There are examples of low flocculating yeasts that are haze positive and examples that are haze neutral. Same with high-flocculating yeasts.

2 — **High protein adjuncts are necessary for haze.** Not true. All of our experiments were conducted with 100% barley malt and we were able to achieve haze levels consistent with the haziest of hazy beers.

3 — **Hazy is lazy.** Not true. Our experiments—and we'd bet yours too—highlight the difficulty of generating consistent haziness from batch to batch. If you don't have the right yeast, it may be a huge R&D effort to build stable haze into a product and make it look as great as it tastes.

THE IPA

If you think your IPA is not reaching its full potential for haze, consider all of the following variables:

Yeast strain choice
Some strains are better at creating stable haze

Dry hop timing
Later dry hopping means more haze

Dry hop amount
More hops means more haze

THE BREAKROOM

Yeast <3 Top Crop
by Bianca Alley

Orders & Process Coordinator (and resident yeast plate artist) Bianca Alley starts with a blank WLN plate and draws anything from seasonal art to personal portraits. Here we can observe a yeast colony taking up the bromocresol green dye as it develops and grows into a perfect rendition of the Top Crop logo.

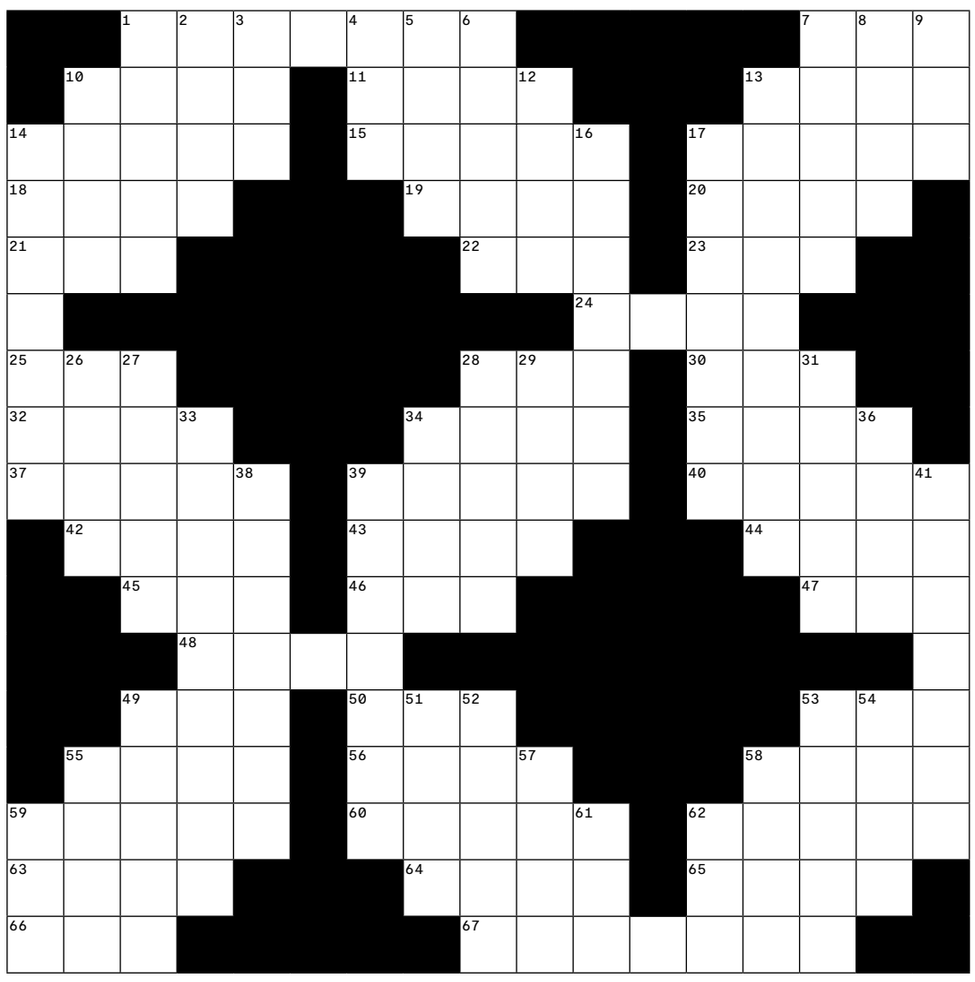
Yeast Strain: Dry Hop Edition
Written by Laura Burns / Illustrated by Dexter Stevens

ACROSS

1. You could measure yeast quantity by this instead of counting cells
7. Alternative to kgs
10. Work place
11. You can't drink all day if you don't start in ___orning, says Founders Breakfast Stout
13. Non-natives call California this for short, say natives
14. Injures
15. When someone can't hear you on Zoom
17. The one before
18. Golden, pale and blond
19. Adjust an instrument
20. Vacation rental app with no breakfast
21. Blemish
22. 33-down is an example of this
23. Hallucinogen, or waterfront roadway in Chicago
24. ___ mash
25. 6th sense, for short
28. Sorrow
30. ___ way the wind blows
32. For hop plants, its called a bine (it twines)
34. Where the hot break happens
35. Dregs for winemakers
37. Having to do with ebb and flow
39. Brewery whose beer is brewed aggressively, in Minnesota
40. Fruity flavor compound in beer
42. With up, to disturb or annoy
43. Throw casually
44. An animal's male parent
45. Like Advil, no doctor's Rx needed
46. A malted grain used for brewing
47. Yeast's genus, very briefly
48. One of the world's most active volcanoes
49. Irn ___; Scotland's soda
50. A very pop. style of hoppy beer, broadly
53. Drink a small amount of liquid
55. Suds
56. Cocoa ___
58. It's a whole mood
59. Prolonged battle
60. Pennsylvania, Colorado or Florida
62. Corona, Noro or Trojan
63. Champion, idol or large sandwich
64. Ring-shaped mark left by a bud
65. Uses fractional freezing on beer
66. Units of time for cellar aging maybe, for short
67. Head in the fermenter during active fermentation

DOWN

1. Hat that's green, raspberry and French
2. Altru- and optim- are good ones; rac- and fasc- are bad ones
3. Gives the go-ahead
4. It gives you withdrawals
5. An open and ___ case
6. Opposite of tear down
7. Scottish for land owner
8. A fish that looks normal in the deep, but that's named for having this shape on shore
9. With Madam, a formal title
10. Mustached painter of melting clocks
12. List of food and drink
13. A signature characteristic of a pilsner
14. Having the most colloidal turbidity
16. ___ populated, like Chicago
17. Sierra Nevada's famous one of these was released in 1981
26. What a mash tun agitator can do that homebrewers may do manually
27. Spherical hop-tolerant LAB
28. Opposite of better
29. Essential component of hops
31. Mythical Himalayan beasts and a trendy cooler brand
33. A maltster's doppelganger; see 22-across
34. Anchored marker floating in water
36. Que ___
38. Speak to teach
39. Yeast varieties within a species (Omega Yeast lists more than 80 in their catalog)
41. How-tos with ingredients, proportions and processes
49. Brewskis
51. Stone fruit features
52. Taken ___
53. It alerts or allures
54. Measurements of bitterness, for short
55. A cold one, in Berlin
57. ___ San
58. Bad habit
59. Timid
61. Long time
62. vis-a-___



Scan code for answers

An educational engine from the curious minds behind Omega Yeast, Top Crop delivers relevant, informative content for brewers and fermentation enthusiasts in a way that's engaging, sometimes entertaining, and always easy to digest. Our insight is inspired by our own creative experimentation and the work we do with thousands of brewers every year.

Our team of contributors is made up of writers, researchers, brewers, photographers, scientists, home cooks, beer drinkers, and more. We thrive on digging into the fine details, poring over research papers, designing assays, conducting experiments, and putting it all together to bring our readers the latest insights into all things fermentation. We encourage you to get in touch with us and let us know what's driving your curiosity.

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Stay fresh.