

Understanding Yeast: Homebrewing Basics



Bridger Brew Crew
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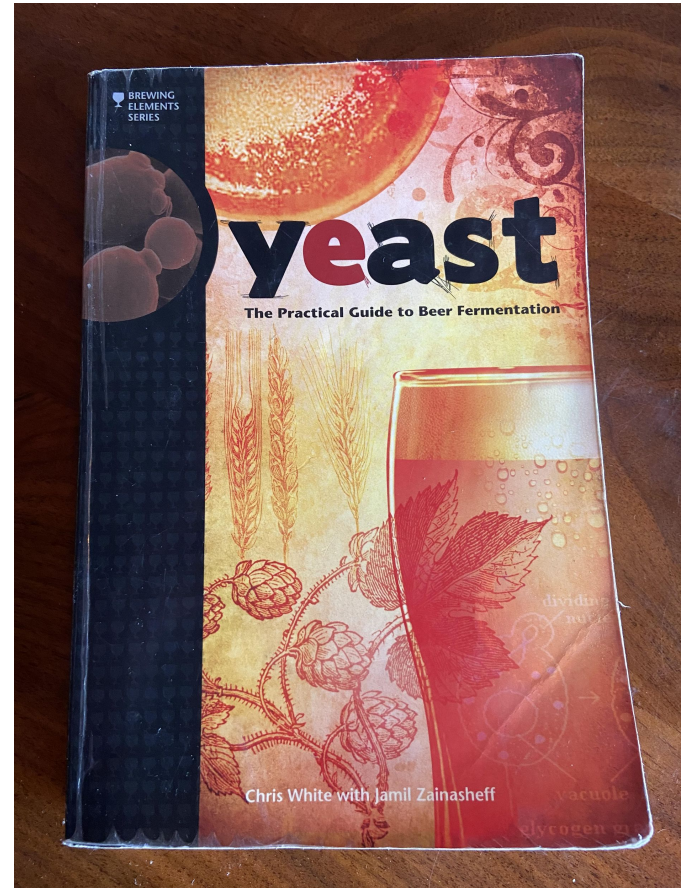
Overview

In part one of our yeast workshop you can expect to learn about:

- The different types of yeast used in brewing
- How yeast actually work
- How to determine the right pitching rate
- How to create your own yeast starter
- Tips to optimize yeast vitality

To Learn More...

A large portion of the content presented here today is from reading **“Yeast: The Practical Guide to Beer Fermentation”** by Chris White and Jamil Zainasheff. It is a great resource and reference for all things about yeast and brewing.



Why Care About Yeast?

- Yeast arguably makes the largest flavor contribution to your beer
 - This can be good flavors or bad flavors
- Many of the most impactful ways to improve the quality of your homebrew are yeast focused
 - Using quality liquid yeast
 - Temperature control
 - Making a starter
 - Using healthy yeast

Categories of Yeast

Yeast can be categorized in several different ways and there are certainly exceptions to any classification system, a fairly simple approach is as follows

- *Saccharomyces Cerevisiae* - Ale Yeast
 - American - clean
 - English - fruity
 - Belgian - phenolic
- *Saccharomyces Pastorianus* - Lager Yeast
 - German - clean
- Hybrid Yeast - combines characteristics of ale/lager strains
 - Ale strains that ferment colder generally associated with albiel and kolsch
 - California common, often called a hybrid but is technically a lager strain
- *Brettanomyces* - Wild Yeast

What Does Yeast Actually Do?

- Consumes oxygen as it goes through the growth phase
- Turns sugars into alcohol and CO₂
- Creates esters and phenols
- Creates off flavors, diacetyl, acetaldehyde, etc under certain circumstances
- Cleans up off flavors such as diacetyl
- Goes Dormant

Technical Phases of Yeast Activity

- Lag:
 - 0-15 hours
 - Uptake of nutrients and oxygen
 - No visible activity
- Exponential Growth:
 - 1-4 days
 - Consuming sugars, making ethanol, CO₂, flavors
 - Krausen is present
- Stationary:
 - 3-10 days
 - Growth slows, off flavors are cleaned up, flocculation occurs
 - Krausen begins to drop

Pitching Rate...Why is it Important?

- Consistency of flavor
- Less lag. Less contamination risk
- No unexpected flavors
- Less diacetyl, acetaldehyde
- Assure full attenuation
- Faster fermentation
- Healthy yeast for future generations

Pitching Rate Targets

Ales: .75-1 million cells per ml per degree plato*

Example

- Target is .75 million cells / ml / degree P
- 12P (1.048 SG) @ 5.3 gallons
- 750,000 cells x 20,000 ml of wort x 12 plato
- You need: 180 billion viable cells

Lagers: 1.5 million cells per ml per degree plato

Example

- Target is 1.5 million cells / ml / degree P
- 12P (1.048 SG) @ 5.3 gallons
- 1,500,000 cells x 20,000 ml of wort x 12 plato
- You need: 360 billion viable cells

High gravity wort 25P or 1.106 is very similar to a lager pitching rate

- Target is 1.4 million cells / ml / degree P

Yeast Viability

- Pitching rate only considers the amount of live or viable cells, pitching dead yeast cells does not contribute to the count
- Cell counts off the shelf for liquid yeast are generally 100 billion cells when fresh
- Vitality of liquid yeast is constantly dropping after manufacture
 - 2 weeks old viability ~87%
 - 1 month old viability ~77%
 - 2 months old ~53%
 - 3 months old ~32%
 - 4 months old ~11%

How To Hit the Correct Pitching Rate

- Know how many yeast cells you are starting with, most yeast producers target 100 billion cells per package, but note some new providers are going higher.
- Multiply the total number of cells by the estimated percentage of viable cells to know how many viable yeast cells you are starting with
 - $100 \text{ billion} \times .77 \text{ (1 month old)} = 77 \text{ billion yeast cells}$
- In our Ale example from before we needed 180 billion yeast cells
 - $180 / 77 = 2 \frac{1}{3}$ packages of yeast
- If you only have 1 package of yeast or don't want to spend the extra money on multiple yeast pack it's time to think about making a **Yeast Starter**

Yeast Starters

- Making a yeast starter has many benefits:
 - An increased cell count
 - Improved yeast vitality/health, fewer off flavors,
 - A reduction in lag time before active fermentation starts
 - A faster overall ferment
 - Less chance of yeast derived off flavors
- Always make a starter if your yeast is old, got hot in shipping or for any reason you might think it has low viability and/or vitality.

A Quick Note on Dry Yeast

- General guidance says to not make starters with dry yeast (but you certainly could)
- Pitching multiple packets of dry yeast is cheap and easy
- Most dry yeast has an average cell density of 20 billion cells per gram and costs relatively little
- When using dry yeasts follow the manufacturer's suggestion for proper rehydration, not doing so may kill a higher percentage of yeast cells as they rehydrate.
- For the remainder of this discussion the focus is on liquid yeast

Steps To Make a Simple Starter

- Target your starter wort to be 1.030-1.040 specific gravity
 - Low gravity starters will have less growth and stress the yeast less
 - High gravity starters will have more growth but stress the yeast more
- For example just under 1/2 lbs dry malt extract dissolved in 2 quarts H₂O, or 200g DME in 2 liters H₂O
- Consider adding yeast nutrient
 - Wyeast has already taken care of this for you inside the yeast package
- Boil for 15 minutes
- Cool the wort
 - Target the starter temperature to be within 10 F of the beer you'll be adding it to to avoid shocking the yeast
- Add cooled wort to a sanitized container
- Sanitize the outside of the yeast packaging
- Pitch yeast from package
- Consider adding O₂ or using a striplate
 - Stir plates add Oxygen, drive off CO₂, and keep yeast suspended all of which increase cell growth, 2-3x greater growth than a non-stirred starter

The Different Types of Starters

Vitality Starter - For when you are short on time and/or don't need to grow additional yeast

- Quick ~4 hrs
- Use a stir plate or shake it constantly
- Low or no growth of yeast cells will occur
- Yeast respire but does not ferment
- Vitality is being restored and getting the yeast ready to ferment
- Starter volume is not as important, .5 to 1 liter suggested
- Pitch the whole thing into your wort

High Krausen Starter - For pitching yeast at the peak of growth and activity

- 1-3 days, depending on the size of the starter
- Time so the starter is pitched when the yeast is almost done with the growth phase
- Bulk of yeast growth is usually done in 12-18 hours
- Benefit is yeast are very active and don't have to restart from dormancy
- Pitch the whole thing into your wort
- Best way to get extra attenuation when dealing with a stuck ferment

Growth Starter - For when you need to grow additional yeast and can plan ahead a few days

- 2-3 days minimum
- Use a stir plate or shake it frequently
- Allow yeast to ferment the starter fully and then flocculate, a cold crash can help
- Decant liquid and pitch yeast slurry
- Overall starter volume is important because it affects growth, 1 liter minimum

What Size Starter to Make

- The size/volume of the starter dictates
 - The amount of food available for the yeast
 - How dense the population of yeast will be
- The ratio of starter size to the amount of yeast added to the starter is critical for growing additional yeast
- Significant growth only happens with a starter about 1L in size
 - With one pack of yeast and 1L you can grow ~50% more cells
 - 100 billion cells grows to 150 billion
- To double the yeast population increase the starter size to 2L
 - With one pack of yeast and 2L you'll can grow ~100% more cells
 - 100 billion grows to 200 billion

Stepping up a Starter

Stepping up a starter is the process of adding more wort to your starter after a few days of growth/activity. This process is one way to encourage more cell growth when making a starter. But there are important factors to consider when attempting to do so.

A stepped starter will only grow significant additional yeast when the subsequent step is 5-10 times larger than the original

- Useful if you have a very small amount of yeast, such as bottle dregs
- For example: Begin with a 100ml grow and then add more wort to step up to 1 liter

Logistical Considerations:

- A small starter, less than 1L promotes very little initial cell growth
- Starting with 1L the next step up to 5-10 liters is often not feasible or practical for homebrewing
- A slightly more feasible option according to Wyeast a single pack of yeast in a 1 liter starter, then pitched into 4 liter starter = 400 billion cells

Do I Really Have to Make a Starter?

Hopefully the benefits of making a starter are now obvious to you but we often still hear people suggesting that they make perfectly fine beer without a starter. Yeast manufacturers provide an interesting take on this subject. Lab grown yeast has been grown in a truly ideal environment and may mean that the pitch rates for such yeast could be lower than typically recommended.

- Average ale example with a fresh package of commercial yeast
 - Target is .5 million cells / ml / degree P
 - 12P (1.048 SG) @ 5.3 gallons
 - Math: 500,000 cells x 20,000 ml of wort x 12 plato
 - You want: 120 Billion Cells

So in this case a **fresh** package of yeast can give you 100 billion cells of yeast when you're looking for 120 billion, this is only a slight underpitch, 83% of the recommended pitch. So with fresh yeast and paying attention to other factors for healthy yeast you can probably get away without making a starter, but it is still pretty darn easy to make a starter.

Healthy Yeast - Add Oxygen

- Oxygen is critical for yeast reproduction, specifically cell wall building
 - Without O₂ cells will be smaller and have weak, leaky cell walls that allow more off flavors into the beer instead of staying inside the yeast cell
- Oxygen levels should ideally be 8-10ppm O₂ in the wort right before the yeast is pitched
- There are several approaches to adding oxygen to your wort
 - Shaking the fermenting bucket for 5 min maxes out at ~4ppm O₂
 - Ambient air through a stone for 20-30 maxes out at ~8ppm
 - Pure O₂ through a stone for 1 min ~9ppm
- Higher gravity wort needs more yeast, causes more cell growth, thus needs more O₂.
 - Pure O₂ is really the only method to get enough O₂ for high gravity oxygenation
 - A second dose after 12-18 hours may also benefit the healthy growth of yeast

Healthy Yeast - Nutrients

- Creating an all malt wort will generally provide everything for proper yeast nutrition except oxygen and zinc
 - Sugar - yeast's basic food
 - Nitrogen - typically in the form of amino acids, yeast can make the needed amino acids or absorb them directly from the wort
 - Phosphorus - critical for cell dna replication, lack of phosphate can lead to stuck or incomplete fermentation
 - Vitamins - critical for enzymatic reactions, yeast cannot create these themselves
 - Minerals - calcium, potassium, magnesium, and zinc are critical for reproduction and alcohol production
- Adding a dose of yeast nutrient is an easy way fill in the gaps and bolster the amount of nutrients available for the yeast
- Servomyces yeast nutrient is dead yeast cells which were grown with metal ions such as zinc and magnesium, thus naturally providing the full spectrum of required nutrients in a small dose of nutrients.

Healthy Yeast - Pitching Rate

Not using the proper pitching rate can negatively impact the level of nutrients available to yeast. During the growth phase yeast cells will ideally divide four times to reach maximum population.

- Each cell division reduces the nutrients available in a single yeast cell
- Underpitching forces the yeast cells to go through too many divisions and results in nutrient deficient cells

Healthy Yeast - Avoid Stress

- Underpitching and Overpitching can both cause stressed yeast
 - Analogy for overpitching: 100 people at a party and the host orders 1 pizza to feed everyone, everyone worries they won't get enough to eat.
 - Analogy for underpitching: 1 person has to eat 100 pizzas, it's going to take a long time and that person is not going to feel very good at the end of it.
- High acidity - an overly acidic environment is not ideal for yeast. Increasing the pitch rate may help complete the fermentation but reusing such yeast is not advised.
- High gravity - even with a proper pitch rate the amount of effort to complete a large fermentation and the higher levels of alcohol will stress yeast, again reusing yeast after such a fermentation is not advised.

Topics for Next Time

Part 2 of the Yeast Workshop will happen soon.

Topics will include:

- Cell Counting
- Reusing Yeast
- Capturing Yeast
- Yeast Related Off Flavors