Home Brewers Yeast 101

David Segletes

CAROLINA BrewMasters CHARLOTTE

Topics to be covered

- Introduction
- Choosing the yeast for your batch
  - Flavor
  - Flocculation
  - Attenuation
  - Alcohol Tolerance
- Pitching Rates
- Oxygenation
- Fermentation Temperature
- Diacetyl
- Reuse

Introduction

Yeast are living organisms that respond to their environment. The most important factors that affect yeast performance that a brewer can control are:

- Grain bill/Mash schedule (spectrum of fermentable sugars)
- Water chemistry
- Wort original gravity (OG)
- Nutrient content (additions if any)
- Pitch rate
- Oxygenation/Aeration
- Choice of yeast strain
- Fermentation temperature
- Sanitation

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Yeast Flavors

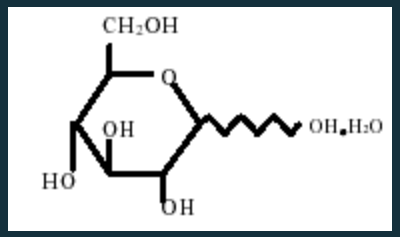
- Need to pick yeast to style – every yeast strain is unique
- Start with the end in mind
- Flavors are certainly affected by
  - Pitch rate
  - Fermentation temperature

Flocculation

- Listed on yeast data sheet
  - High (clear - lagers, IPA's, etc)
  - Medium
  - Low (cloudy – Wit, Weizen)

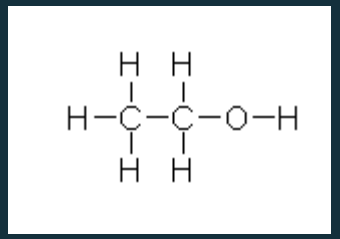
Attenuation

- Measure of sugar to alcohol conversion ability
- Listed as a percent reduction of OG
- Highly attenuative yeast can result in a dry beer with high alcohol content



DEXTROSE

ETHYL ALCOHOL



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Alcohol Tolerance

- Measure of ability of yeast to live in a high alcohol environment
- Listed as % Alcohol by Volume – this is your expected finishing %ABV
- Important when brewing beers with a high OG - Barley Wines, Belgians, Imperial Anythings
- Yeast nutrient can help raise Alcohol tolerance. Also adding dissolved candi sugar to Belgians after initial fermentation has subsided can help.

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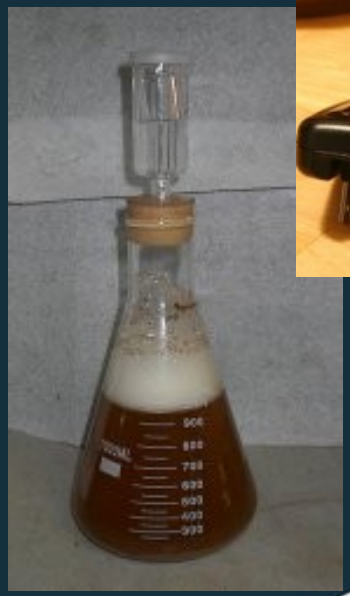
Pitching Rates

- Pitch able Tube / Smak Pak has 6 million cells/ml
- Can effect flavor
  - A low pitch rate can lead to:
    - Excess levels of diacetyl
    - Increase in ester formation
    - High terminal gravities
    - Stuck fermentations
    - Increased risk of infection
  - A high pitch rate can lead to:
    - Very low ester production
    - Thin or lacking body/mouthfeel
    - Autolysis (Yeasty flavors due to lysing of cells)

STYLE	GRAVITY	PITCH RATE (Million Cells/ml.)
Ale	<1.060 (15P°)	6.00
Ale	<1.061-1.076 (15-19P°)	12.00
Ale	>1.076 (19P°)	>18.00
Lager	<1.060 (15P°)	12.00
Lager	<1.061-1.076 (15-19P°)	18.00
Lager	>1.076 (19P°)	>24.00

Starters

- Easy way to increase cell count
- Stir plate not necessary but helpful
- Basically a mini batch
- See handout for more info



Oxygenation

- Needed for yeast reproduction
- All available oxygen consumed within first few hours after pitching
- Leads to strong cells and better overall fermentation
- Several methods employed
- Optimum level of dissolved oxygen is 8 ppm

Method	DO ppm	Time
Siphon Spray	4 ppm	0 sec.
Splashing & Shaking	8 ppm	40 sec.
Aquarium Pump w/ stone	8 ppm	5 min
Pure Oxygen w/ stone	0-26ppm	60 sec (12ppm)

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Fermentation Temperature

- Ales
  - Typically top fermenting strains
  - Temperatures > 60°F
- Lagers
  - Typically bottom fermenting strains
  - Temperatures < 50°F
- Hybrid (California Common or Düsseldorf Alt)
  - Can be top or bottom fermenting
  - Temperatures 50°F - 60°F

Diacetyl

- Diacetyl is a natural by-product of yeast. It is most commonly recognized as a butterscotch or buttered popcorn flavor in the beer.
- Some people are very sensitive to diacetyl.
- Normally considered a critical flaw in competition
- To minimize the diacetyl attributes in beer, it's recommended that the fermenting wort rest once the beer has reached terminal gravity for 48 hours at 62-70 degrees prior to crashing the temperature. This stage allows to yeast to reabsorb the diacetyl.

Reuse

- Never re-use yeast from a high gravity fermentation (greater than 1.070 original gravity).
- Never re-use yeast from an irregular fermentation.
- Never re-use yeast from a fermentation with off flavors and aromas.
- Never re-use yeast if you are not confident in your sanitation and brewing practices.
- **A $7 package of yeast is better than a ruined batch**

Questions

Yeast Starter ... pun intended

by David Segletes – member Carolina Brewmasters

Ahh yeast, usually the last ingredient we add in our delicious batch of home brew before we sit back and relax after a session. Those lonesome little critters that do all the hard work for the brewer. They eat the sugars we all grain brewers worked so hard to extract from the starches stored up in those kernels. They devour the sugars and pee alcohol, poop flavor compounds and fart CO2. Yeast may be the one ingredient that can make or break an award winning beer, because the wild ones can certainly ruin it. They have all sort of personalities and like us react to the environmental conditions around them. It has be determined that over 500 different flavors and aromas are derived from yeast.

So what does a brewer need to know about yeast? Well there are two main types of yeast, ale and lager. Ale yeasts are referred to as top-fermenting because much of the fermentation action takes place at the top of the fermenter, while lager yeasts would seem to prefer the bottom. While many of today's strains like to confound this generalization, there is one important difference, and that is temperature. Ale yeasts like warmer temperatures, going dormant below about 55°F (12°C), while lager yeasts will happily work at 40°F. Using certain lager yeasts at ale temperatures 60-70°F (18-20°C) produces a style of beer that is now termed California Common Beer. Anchor Steam Beer revived this unique 19th century style. Also the brewer must, understand the flavors you expect from your beer and choose a yeast accordingly. For example one would not want to use a clean West Coast ale yeast to produce a German HefeWeizen! On the other hand, you could use a yeast that is intended for a German Alt/Kölsch instead of a lager yeast if you do not have full lagering capabilities. So, how do I know what to expect from a yeast? Well you have to do some research. The yeast manufacturer websites have a wealth of knowledge. Also the Brew Your Own magazine website (www.byo.com) has a nice chart. Most will list several key factors - flocculation: attenuation, temperature range, and alcohol tolerance.

Flocculation is a term used to describe how the yeast behaves at the end of fermentation. The higher the flocculation, the better the yeast will clump together and fall to the bottom of the fermenter. So, a yeast with high flocculation should result in a crystal clear beer. Thus you would not want a yeast with high flocculation for that Belgian Wit or German Hefe Weizen. On the other hand, a yeast with high flocculation is needed for that crystal clear lager that will make the BMC crowd drool. So through yeast selection you can affect the clarity of your beer. There are other factors that effect the clarity, but yeast selection plays an important role. Other factors that influence the clarity are mash schedule, grain bill, boil time, and addition of clarifiers (eg Irish Moss).

Attenuation is a term used to describe how well the yeast will convert the sugars in the wort to alcohol. A yeast with an attenuation of 100% will have a final gravity of 1.000. Therefore a yeast with an attenuation of 80% should take a wort with an original gravity (OG) of 1.060 to a final gravity (FG) of 1.012. This is calculated using the formula [(OG-FG)/(OG-1)] x 100. There are some things that make this not 100% accurate though, one such fact is that alcohol has a lower density than that of water and affects the FG reading, thus we call this measurement apparent attenuation. Also sometimes there are non fermentable sugars in the wort that will raise the final gravity, at no fault to the yeast. By selection of the yeast strain the brewer can influence what the final gravity will be which in turn has an impact on the mouth feel of the beer.

The temperature range listed by the manufacturer is the optimum range fermentation should take place for a given stain of yeast for it to have the characteristics listed. The fermentation

temperature can have a substantial impact on the flavor compounds produced. Many brewers that like the Belgian and Wheat beer styles play with fermentation temperatures to get the flavors they want. It should be noted that these are recommended ranges and if you feel adventurous, go ahead and step out of convention! I am sure your home brew will be great. The brewer should monitor the temperature of their fermenting brew and keep a log so that award winning batch can be repeated!!!! Fermenting at too high a temperature can result in fusel alcohol production as well as unwanted ester production. Fermenting at too low a temperature can result in a slow fermentation that raises the risk of infection. It can also result in a stuck fermentation in which the yeast just stops working. Raising the temperature can get this restarted. An incomplete fermentation can result in high levels of retained diacetyl.

The alcohol tolerance is just that. These little creatures can get drunk too. At a certain point, they either die or go dormant. Normally this is given as % ABV, so from your original gravity and the expected attenuation, see if the yeast you want to use will work well. The selection of the yeast should take into consideration the expected original gravity the yeasts attenuation and what the expected alcohol level will be. Adding yeast nutrient can increase the alcohol tolerance of a given yeast by building stronger cell walls. This is important when brewing "imperial" styles, barley wines, and Belgians. Some brewers use the alcohol death of yeast to control the residual sweetness.

So now that you know what is on the data sheets for your particular stain of yeast, you are probably ready to brew. Well, there are a couple of things to think about before you get started. What is your expected OG??? You may want to consider making a starter. This is especially true for those wanting to try their hand at a lager. The cold fermentation temperature of lagers requires a high yeast cell count. Consistent and reproducible fermentations are not possible without consistent and adequate pitch rates. The quantity of yeast added to the fermenter will affect every aspect of your finished product, from attenuation level, to flavor and aroma profile, to clarification. The table below gives some typical pitching rates. The Wyeast and White Labs pitchable packages have approximately 100 billion cells, which for a 5 gallon batch, corresponds to a pitching rate of 6million cells/milliliter.

STYLE	GRAVITY	PITCH RATE (Million Cells/ml.)
Ale	<1.060 (15P°)	6.00
Ale	<1.061-1.076 (15-19P°)	12.00
Ale	>1.076 (19P°)	>18.00
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You should be able to see that these pitchable yeasts are designed for ales with an OG of less than 1.060. For a stronger batch, you either need another package of yeast or a starter. This article will not cover ground already covered previously, but there is a nice article on the CBM website and Bill Lynch wrote a nice article for the 2nd quarter 2008 CBM newsletter (http://www.carolinabrewmasters.com/CBM_2Q_2008_Newsletter.pdf).

Pitch can rates make a dramatic difference in the final flavor and aroma profile of any beer. Ester production is directly related to yeast growth as are most other flavor and aroma compounds.

A low pitch rate can lead to:

* Excess levels of diacetyl
* Increase in higher/fusel alcohol formation
* Increase in ester formation
* Increase in volatile sulfur compounds
* High terminal gravities
* Stuck fermentations
* Increased risk of infection

High pitch rates can lead to:

* Very low ester production
* Very fast fermentations
* Thin or lacking body/mouthfeel
* Autolysis (Yeasty flavors due to lysing of cells)

So once you have enough yeast, go ahead and brew. Make sure you have your wort at pitching temperature (about 65°F) before you pitch the package of yeast or your starter. Pitching at a higher temperature is possible but is hard on our little friends. They need oxygen to reproduce, develop strong cell walls and get started. Yeast cells require about 10ppm of dissolved oxygen for healthy growth. The best way to treat our little friends to give them some love in the form of oxygen. Some people use the spray method as they transfer their wort to the fermenter. Some use the shake rattle and roll technique and some pump it up with an aquarium pump. The best way is to use a diffusion stone and a bottle of welding oxygen. Wort has an oxygen content of about 8.5 ppm when saturated with air (79% nitrogen and 21% oxygen) and an oxygen content of about 43 ppm when saturated with oxygen. Sixty seconds with an oxygen bottle and you are there. See the table below for dissolved oxygen values from the Wyeast website. You can also help out the little bugs by adding some yeast nutrient.

Method	DO ppm	Time
Siphon Spray	4 ppm	0 sec.
Splashing & Shaking	8 ppm	40 sec.
Aquarium Pump w/ stone	8 ppm	5 min
Pure Oxygen w/ stone	0-26ppm	60 sec (12ppm)

Once your wort has been fermented into beer, what do you do with all those little guys? Some people like to reuse their yeast. I will not cover this as Mark Graham from CBM covered this very well in the December 2007 CBM newsletter (http://www.carolinabrewmasters.com/3Q4Q_2007_Newsletter.pdf). Just make sure your sanitation practices are good and you should be OK. Do not reuse the yeast if anything unusual happened as a result of the fermentation (long lag time, off flavors) or from a high gravity fermentation (OG >1.070).

Well I hope you have enjoyed this and please take some time to make a friend with Saccharomyces cerevisiae or of you are feeling perky, buddy up with some Brettanomyces.