BJCP Study Group

September 13 2017

Saaz Church

Malt and the Malting Process

& Yeast Selection

Why We like Beer !

List three primary purposes of the BJCP as listed on http://www.bjcp.org/ and in the BJCP Study Guide.

- Promote beer literacy
- Promote the appreciation of real beer
- To recognize beer tasting and evaluation skills.

BJCP rank Matrix

BJCP Level	Minimum Exam Scores	Total Experience Points	Minimum Judging Points	GM Service Requirements
Grand Master II and Up	>90	100/lvl	50/lvl	Yes
Grand Master	>90	100	50	Yes
Master	> 90	40	20	Yes
National	80-90	20	10	No
Certified	70-80	5	2.5	No
Recognized	60-70	0	0	No
Apprentice	<60	0	0	No

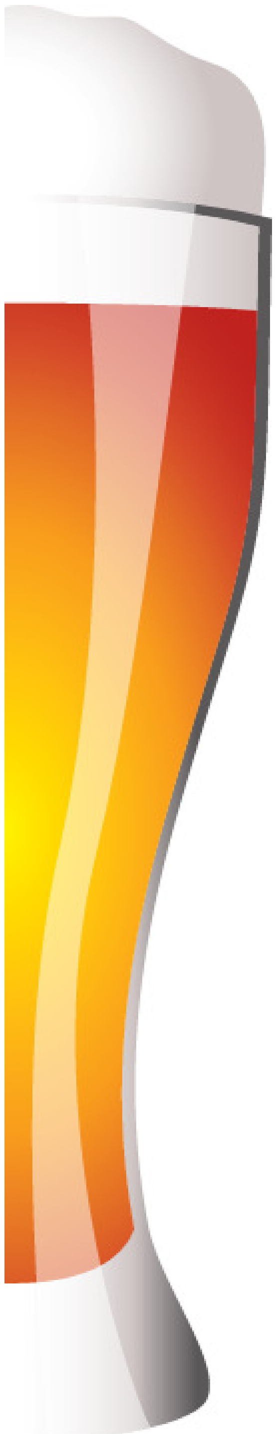
Outline:

- Summary of the malting process
- Types of malt
- Beer styles associated to particular malts
- Yeast – Growth Cycle
- Five yeast selection strain considerations
- Possible Test Question

Possible Test Question

T15. This question addresses two separate ingredients, malt and yeast. Please provide the following information in your answer: (1) Identify and describe the different types of malts by their color and the flavor they impart to the beer, and give at least four distinct styles with which specific malts are associated. (2) Provide five distinct considerations in selecting the appropriate yeast strain for a given beer style.

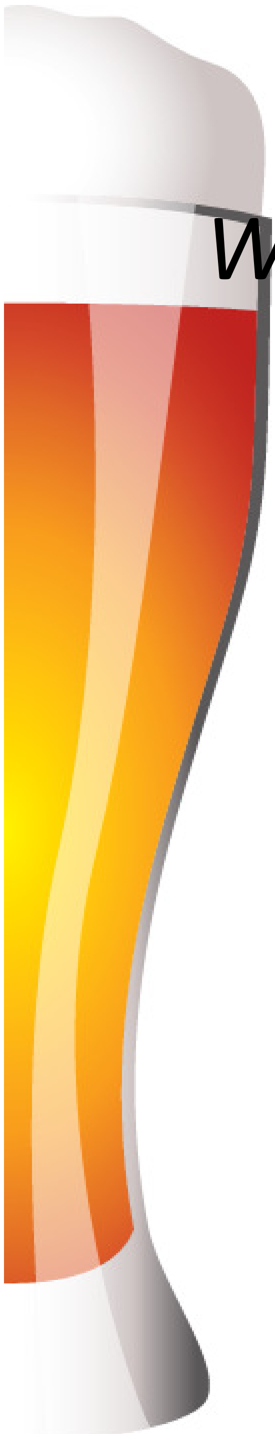
25%	Identify types of malt.
35%	Identify types of malt associated with at least four beer styles
40%	Provide five distinct yeast strain selection considerations



Overview of the process:

Four basic steps (for “base” malts)

- Steeping roughly 48 hrs, raise moisture levels, begins to sprout
- Germination around 5 days until desired level of modification
- Drying at low temperatures
- Kilning to desired color, flavor
- Specialty malts handled differently



A nagging question:
Why should this process work so well to make beer????

Answer 1: *“**Beer is proof that God loves us and wants us to be happy.**”*

Answer 2: Evolutionary advantages of long-term storage.

What sort of barley?

Poetic description of malting by Robbie Burns

There was three kings into the east,
Three kings both great and high,
And they have sworn a solemn oath
John Barleycorn should die. ….

They filled up a darksome pit
With water to the brim;
They heaved in John Barleycorn,
There let him sink or swim.

They laid him out upon the floor,
To work him farther woe;
And still, as signs of life appear'd,
They toss'd him to and fro.

They wasted, o'er a scorching flame,
The marrow of his bones;
But a miller us'd him worst of all,
For he crush'd him between two stones.

And they hae taen his very heart's blood,
And drank it round and round;
And still the more and more they drank,
Their joy did more abound.

Steeping/Germination

- After dormancy period (months…)
- Steep at 50-60F
- Usually 40-48 hours
- Raise moisture from ~ 12% to ~ 45%
- When enough moisture, move to germination area (traditionally floor, now compartment)

Steeping chamber

Traditional (!) floor malting

What happens during germination ?

- Lasts about 5 days, usually 57-70F
- Kept moist, aerated
- Acrospire grows
- Starch matrix degrades (break down of cell walls)
- Makes starches “available,” degrades into sugars (amylases…)
- Acrospire length 1.0 = “fully modified”
- Beware old texts/articles!

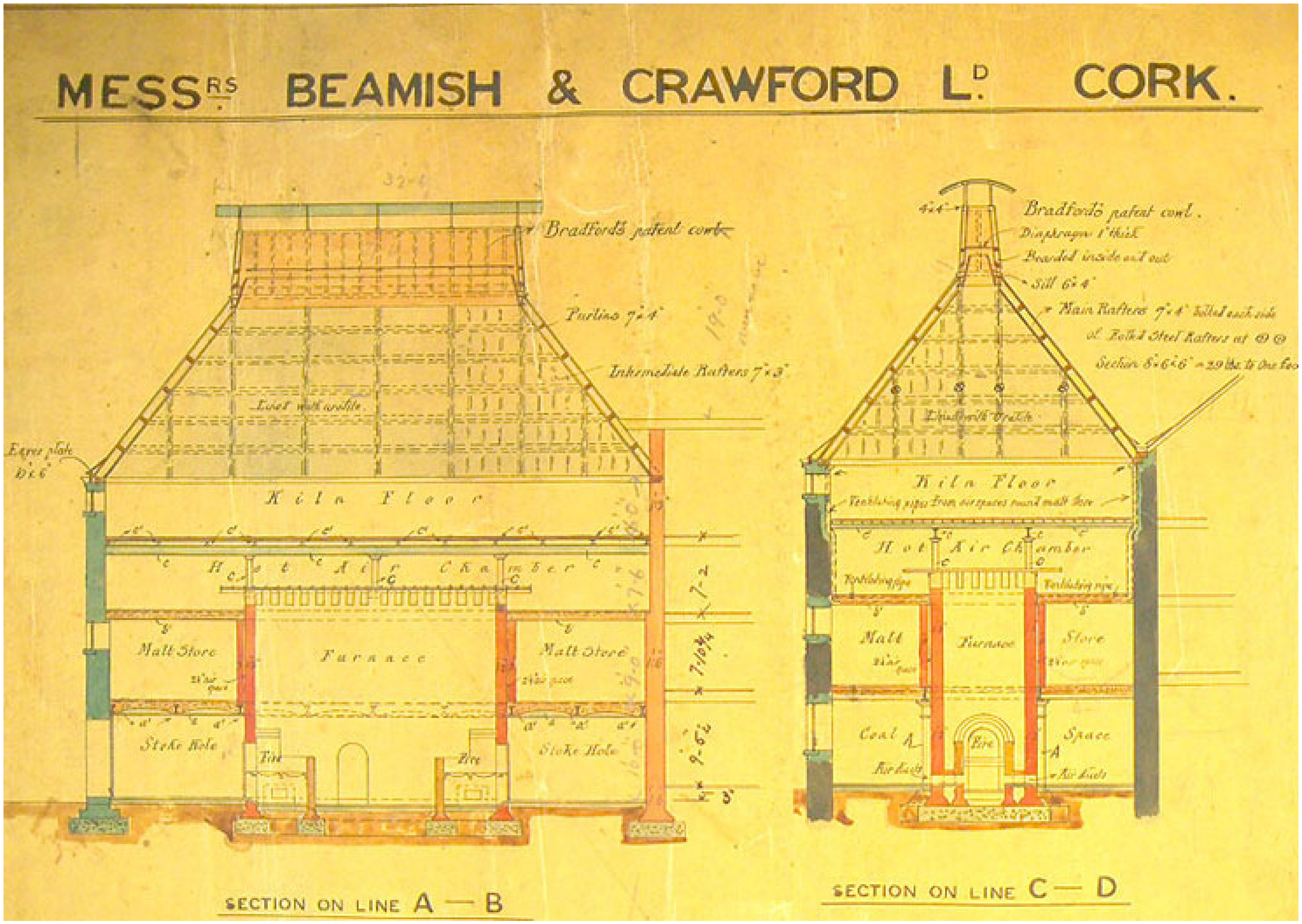
A close up ….

Drying/Kilning

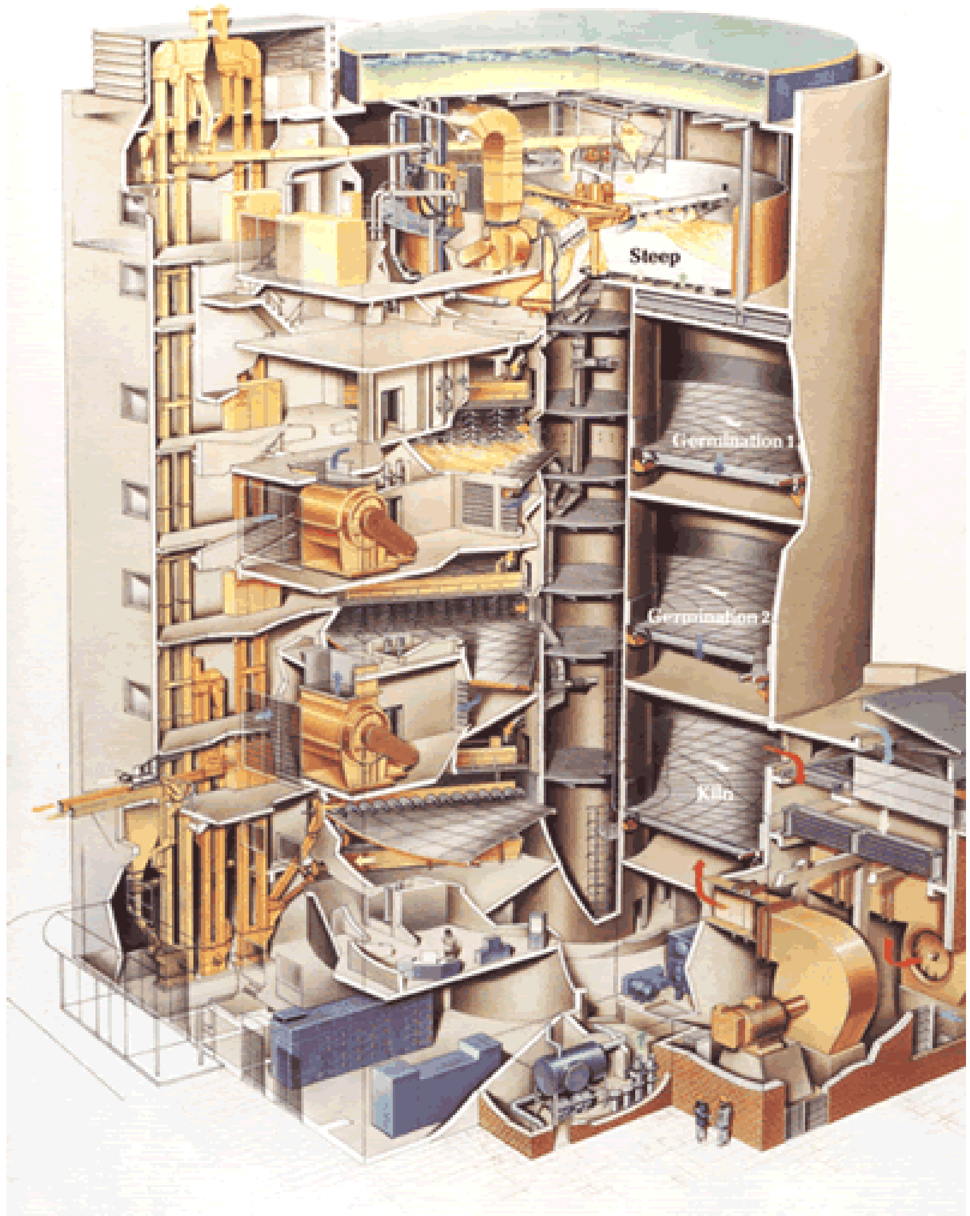
- Drying at 100-120F until moisture < 10%
- Increase temperature (140-160F) until moisture below 6%
- If too hot when too moist, degrade amylase enzymes (so later mash has conversion troubles)
- After drying, kiln to desired color/flavor

Traditional malt kiln (Rodenbach)

Beamish Kiln (1870)



Modern malting (UKMalt)



Types of malt and their production

Pale malt/Pils:

- Drying phase for pale malts: low temp (40-45C) and very high vent until ~10% moisture content, then raise temp for “curing phase.” (If raise temp at high moisture, kill enzymes.)
- Curing phase for pale malts: 80-95C for 5 hrs.
- Full diastatic power. (About 140 deg Linter for American pale, 80 (?) for British pale, ~100 for Pils)

Types of malt and their production

“High-kilned” malts (Munich, Vienna, Aromatic, Melanoidin)

- Drying phase: Higher temp (50C) but lower vent until ~20% moisture content (about twice as long as pale) then raise temp for “curing phase.”
- Curing phase:
  - Vienna ~ 90C
  - Munich ~ 105C
  - Aromatic and Melanoidin ~ 115C

Diastatic Power for Vienna/Munich ~ 30 deg Lintner

Types of malt and their production

Crystal/caramel:

- NO Drying phase!
- 60-70C while "green malt," plus added water, until conversion."
- … the vent and cure …
- Curing phase for crystal/caramel: 150C for 1-2 hrs, until desired color.
- No diastatic power at all.
- Can be steeped since fully converted.

Types of malt and their production

Roasted malt (Biscuit/Victory/Chocolate/Black Patent):

- Usual drying phase for pale malt. (Often start with actual pale malt.)
- Roasting barrel at desired temp to desired color.
- No diastatic power at all.
- Can be steeped since all starches roasted into “nonedible” form.

Yeast

Yeast

- Most beer styles are made using one of two unicellular species of microorganisms of the *Saccharomyces* genus, more commonly called yeast. Generally, either an ale yeast (known as *S. cerevisiae*) or a lager yeast (known as *S. pastorianus* or by older terminology *S. carlsbergensis* or *S. uvarum*) is used for the appropriate style. Functionally these yeasts differ in their optimum fermentation temperatures, ability to ferment different sugars, environmental conditions, and ability to settle out upon completion of fermentation, and production and/or metabolism of fermentation by-products. The choice of the strain of ale or lager yeast and how these factors are controlled during the various stages of fermentation will determine how well a beer is made to style..
- **One of the common terms used to describe yeast is apparent attenuation. The attenuation of a particular yeast describes its ability to decrease the original gravity of wort upon fermentation. It is commonly listed as a percent, in which the numerator is the difference between final and original gravity and denominator is the original gravity. Because the density of ethanol is less than water, when a hydrometer is used to measure this attenuation, it will be measuring the apparent attenuation not the real attenuation (if the alcohol was replaced by water).**
- **Another common term used to describe different yeasts is flocculation, which is the ability of the yeast to settle out of the beer upon completion of fermentation; it can vary significantly with strain**.

Yeast

- **Lager Yeast** generally tend to work best between 46-56 °F, but California Common Lager yeast is an exception having a range of 58-68 °F. Apparent attenuation usually ranges from 67-77%. Lager yeasts can ferment raffinose in addition to the sugars that are fermentable by ale yeasts. These yeasts have traditionally been called bottom fermenters, since they do not cling together to form colonies on the surface, but instead fall to the bottom of the fermenter. Lager yeasts can be further subdivided into the Frohberg type (also called dusty or "powdery") which ferment quickly, and do not flocculate as well. Due to the longer time it remains suspended in the wort, this subtype will have a greater attenuation. The other subtype of lager yeast is the Saaz type (also called the S.U. or "break"). These strains tend to flocculate more readily, and hence tend to have a lower attenuation (6). Lager yeasts, in comparison to ale yeasts, produce beers that lack the esters and fusel alcohols, since they are active at cooler temperatures. Lager beer styles should have a cleaner aroma to them, reflecting only the malt and /or hop aromas used to make the wort.

Yeast

- **Ale Yeast**, for the purposes of beer fermentation, tend to work best in the 55-75 °F temperature range. Apparent attenuation can range from 69 to 80%. These yeasts can fully ferment the common sugars glucose, fructose, maltose, sucrose, maltotriose and the trace sugars xylulose, mannose, and galactose. They can partially ferment raffinose. These yeasts have traditionally been called top fermenting because they form colonies (groups of yeast that cling together) that are supported by the surface tension of the beer. Ale yeasts produce esters since they require higher temperatures to remain active. Styles that use these yeasts have varying degrees of fruity and sweet smelling aromas. It should be noted that the yeast used to produce the German weizen style are special strains that generate high concentrations of the clove-like phenols and "bubblegum" and "banana" esters, which are the signature of this style.

~~Yeast~~ BACTERIA

- **Bacteria**, specifically *Lactobacillus delbrückii*, are used in the production of the Berliner Weiss style of wheat beer with an intense lactic sourness. Other microorganisms are also used in the production of some Belgian ales, specifically lambics. Lambics have varying degrees of sourness which is appropriate for their style. Yeasts of the *Brettanomyces* genus and various bacteria generate these flavors. Bacteria are commonly divided into two broad classes based on a laboratory Gram stain. The Gram-negative bacteria involved in lambic production are *Escherichia coli* and also various species of *Citrobacter* and *Enterobacter*, but fortunately they cannot tolerate even moderate alcohol levels and do not survive in the finished beer. The Gram-positive bacteria involved are from genus *Pediococcus* and *Lactobacillus*. These microorganisms use a different pathway than that of *Saccharomyces* yeast known as a mixed acid fermentation pathway. It involves the esterification of the various alcohols to the corresponding carboxylic acids, thus generating the sourness (7).

Yeast Question

- T 15. Describe the stages of yeast development and give five distinct considerations in selecting the appropriate yeast strain for a given beer style. Address the following topics:
- 5 points Provide five distinct selection considerations.

Answer

A. Give five considerations in selecting the appropriate yeast strain for a given beer style.

Consideration	Effect on Beer
Apparent Attenuation	Less residual sweetness (lager yeast) More alcohol Less body
Alcohol	Greater Alcohol by Volume
Flocculation	Less time required for clearing Potentially clearer beer
Temperature	Fruity esters for ale yeasts (higher temperatures) Clean, ester-free beers for lager yeasts (lower temps) Lager yeasts require longer time to finish
Ester/Phenol Production	Fruity flavors/aromas for yeasts high in ester Clean, crisp flavors/aromas for yeasts low in ester production Spicy, clove or peppery phenols in Belgian styles and Bavarian Wheat beers
Diacetyl Production	Butter or Butterscotch flavors Acceptable in low amounts in some styles

Yeast

- **Control of Fermentation By-Products**
- **Esters** may be controlled by the choice of yeast strain, wort gravity, wort aeration, and fermentation temperature. In general ale yeasts produce higher ester levels, although there are variances among different ale strains. Lager yeasts can, if fermented too warm, also produce esters as is practiced in the making of French Bière de Garde styles. Wort gravity also is a factor; the hallmark esters of Belgian Trappist styles are not only due to the yeast strains used but also a result of their high gravity wort. Wort aeration also plays an important role, as the ester production pathway directly competes with the absorption of oxygen and metabolism into sterols . Lastly, fermentation temperature also plays an important role. A four-fold increase in ester production may be observed as a result of increasing the fermentation temperature from 60 to 68 °F .
- **Phenols** can be produced by certain wild yeasts. Hence their control in styles in which they are not desired is a matter of proper sanitation. The one exception to this is German wheat beers, which contain the phenol 4-vinyl guaiacol, which is produced by a special strain of *S. cerevisiae,* from its precursor amino acid, ferulic acid. This phenol may be controlled by the amount of precursor amino acid that is made in the mash during a protein rest at 111 °F .

Yeast

- **Diacetyl** is produced at the beginning stages of fermentation and then later reduced. Maintaining or even increasing the temperature at the end of fermentation can help in its reduction, as will not prematurely removing the beer from the yeast. Oxygen reintroduction can cause its formation through oxidation of diacetyl precursors present in the beer. Ensuring the presence of adequate amounts of amino acids will also help prevent its formation. Extract brewers can often have problems due to the lack of amino acids in the extract. Lastly, diacetyl can be produced by some strains of bacteria. Again, proper sanitation and control during yeast propagation will help minimize its presence .
- **Fusel alcohols** are metabolized from amino acids. As mentioned previously, their production is increased as the fermentation temperature is increased. Also, like esters, fusel alcohols increase with wort gravity. Lastly, various wild yeasts tend to produce excessive amounts of fusel alcohols; hence proper sanitation is important for their reduction .

Yeast

- The environmental conditions that differ with each yeast type and strain are alcohol tolerance, oxygen requirements, and sensitivity to wort composition. Alcohol tolerance describes how well a yeast will continue to ferment as the alcohol concentration increases during fermentation. Most lager yeasts can ferment up to about 8% alcohol by volume, and some ale strains can ferment up to 12% (2,3). Oxygen requirements can differ with each strain as well; some need much more oxygen to be able to ferment without problems. Lastly, different worts will have different relative amounts of sugars present. The various strains can respond differently to the same wort upon fermentation.

Yeast

- The by-products that are produced (and also metabolized) by the yeast are **esters, fusel alcohols, diacetyl**, and **sulfur** compounds. **Esters are produced by yeast combining an organic alcohol and acid.** While approximately 90 different esters have been identified in beer, ethyl-acetate, isoamyl-acetate and ethylhexanoate are most commonly above their flavor thresholds. These impart a fruity, sweet aroma to the beer.
- Another by-product of fermentation is **fusel alcohols**, which contain more carbon atoms than the most common alcohol, ethanol. These are produced by the metabolism of amino acids , and tend to add harsher, more solvent-like tones the beer.
- Yet another by-product is **diacetyl**, which is generally reduced to more benign compounds during the secondary fermentation, but premature removal of the yeast can lead to elevated levels. Its presence imparts a buttery note to the beer. It is produced by an oxidation reaction which can be repressed by the production of the amino acid valine .
- Lastly, there are several **sulfur** compounds that can be produced by the yeast. One of these is hydrogen sulfide, which smells like rotten eggs. Other sulfur compounds exist, but their production is not yet completely understood .

Stages of Yeast Development

- **Describe the stages of yeast development**
- **Name and Describe**
- ***Lag Phase* : Make enzymes, use glycogen, acclimatize to environment**
- ***Growth Phase* : Divide 1-3 times, absorb oxygen, make sterols**
- ***Low Krauesen*: Anaerobic metabolism begins, foam on center of beer**
- **High Krauesen: Most active portion of fermentation**
- **Late Krauesen : Yeast metabolizes fermentation by-products**

Yeast

- **The Yeast Life Cycle**
- When yeast are pitched into fresh wort, the overall process of fermentation can be divided into several stages, all of which are part of the life cycle. While these stages can each be described separately, the transitions between each are continuous and should not be thought of as distinct phases. Also the relative time spent in each phase depends on several factors including the composition of the wort, the environment and the amount of yeast pitched.
- The first phase of the cycle is called the lag phase. During this time the yeast will adapt to the new environment they are now in and begin to make enzymes they will need to grow and ferment the wort. The yeast will be utilizing their internal reserves of energy for this purpose, which is the carbohydrate glycogen. The yeast will acclimatize itself and assess the dissolved oxygen level, the overall and relative amounts of the amino acids and the overall and relative amounts of sugars present. Some of these amino acids, small groups of amino acids called peptides, and sugars will be imported into the cell for cell division. Normally this period is very brief, but if the yeast is not healthy, this period can be very protracted, and ultimately lead to problematic fermentation.

Yeast

- **Based on these factors, the yeast will then move into the next phase of the life cycle, the growth phase. During this time the yeast will start to divide by budding to reach the optimal density necessary for the true fermentation. If an adequate amount of healthy yeast has been pitched and the proper nutrients are present, there should only be one to three doublings of the initial innoculum.**
- **The oxygen that was used to aerate the wort is absorbed during this time to allow the yeast to generate sterols, which are key components of the cell wall . It has also been proposed that cold trub can provide the unsaturated fatty acids needed for sterol synthesis. Furthermore, it has been proposed that if an adequate amount of yeast has been pitched, such that cell growth is not necessary, then the oxygenation is not necessary**
- **While this theory has not been completely accepted perhaps further research will elucidate other variables which may be involved in this phenomenon. This sterol synthesis is the default pathway used in an all malt wort; however if the wort contains greater than 0.4% glucose then this pathway will not be used and the yeast will instead ferment the glucose, even in the presence of oxygen. This effect is called glucose repression, or the Crabtree effect.**

Yeast

- Following the growth phase, the low kräusen phase of primary fermentation begins. During this time the yeast begins anaerobic metabolism, since all of the oxygen has now been depleted. This is characterized by a foam wreath, which has previously existed on the sides, now migrating to the center of the surface. The yeast have now completely adapted to the condition of the wort and transport of both amino acids and sugars into the cells for metabolism will be very active.
- During this period fusel alcohols and diacetyl can be produced.
- To minimize the formation of fusel alcohols, one should try to keep the temperature down, make sure that adequate dextrinous sugars are available, and minimize the amount of hot trub present in the yeast cake.
- To minimize the diacetyl in the finished beer, one should try to avoid the reintroduction of oxygen, excessive cooling of the fermentation in later stages and premature removal of the yeast

Yeast

- . At the high kräusen stage following this, an ale yeast will have metabolized most of the sugars present in the wort.
- A lager yeast, on the other hand, may still be in the growth phase while also reducing the extract by four gravity points/day. Lager yeast will be metabolizing most of the sugars during the high kräusen phase.

Yeast

- . Following this phase is the late kräusen phase.
- In lager yeasts this can be very important, since it is during this time that the yeast begin to metabolize some of the fermentation by-products they had previously excreted during the low kräusen phase. Specifically, a diacetyl rest may be performed to help with the re-absorption and subsequent reduction of the diacetyl and the related 2,3 pentanedione during this time. The temperature of the beer may be allowed to rise up to 68 °F.
- Generally as the extract reaches its terminal point the yeast will begin to flocculate out. It is important not to chill the beer too quickly, which might cause premature flocculation before the fermentation has been completed and all the by-products have been reabsorbed. The general rule of thumb is no more than 5 °F per day; otherwise it is possible to cold shock the yeast.

Yeast

- When the yeast begins to flocculate, the beer is generally racked into a secondary fermenter, which allows for the attenuation of the last remaining extract, usually consisting of the trace sugars. Also removal of the excess yeast and trub will prevent formation of off flavors due to autolysis and/or reactions with trub substrates. For ale styles this period may be very brief, while lager styles may be four to six weeks, or even as long as six months in the case of strong lager styles. It is important during this time to prevent reintroduction of air, since this can lead to oxidation flavors and may introduce contaminants that can infect the beer.
- During packaging of the beer, fresh yeast may often be reintroduced, particularly if it has been lagered for an extended period of time and/or the remaining yeast are not that viable. Two common methods are 1) bottle conditioning, or the addition of a fresh yeast starter and corn sugar (glucose), as is commonly done for Trappist-style Belgian ales, and 2) kräusening, or the addition of freshly fermenting beer as is often practiced with German lagers. For bottle conditioned beers, a 250 ml starter is usually added for a five gallon batch along with the sugar; which provides fresh yeast to metabolize the added sugar. In the case of kräusening, an actively fermenting batch at high kräusen stage is added to the beer being primed. The volume of kräusen added is 20% by volume of the beer being primed. Adding this actively-fermenting beer serves two purposes; it carbonates and also helps clean up any off flavors generated from the previous fermentation.

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Yeast- Oxygen

- Yeast need oxygen to synthesize sterols and unsaturated fatty acids for cell membrane biosynthesis.
- Without aeration, fermentations tend to be underattenuated because oxygen availability is a limiting factor for yeast growth—the yeast stop budding when sterol levels become depleted.
- Higher gravity worts need more yeast for proper fermentation, and thus need more oxygen, but the higher gravity makes it more difficult to dissolve oxygen in the first place.
- Boiling the wort drives out the dissolved oxygen normally present, so aeration of some sort is needed prior to fermentation.
- Proper aeration of the wort can be accomplished several ways:

1. Shaking the container, e.g. the starter jar
2. Pouring the cooled wort into the fermenter so it splashes,
3. Using a bronze or stainless steel airstone with an aquarium air pump and using it to bubble air into the fermenter for an hour.

   When using an airstone and a microbial filter for aeration. The filter is a HEPA (medical) syringe filter or alternatively one can be made from a plastic tube, moistened cotton, and rubber stoppers. The moist cotton provides the filtering action and should be thrown away after each use.
4. Using an airstone and adding pure oxygen to the wort in the fermenter (30 seconds ?) Direct injection to wort as cooling at 0.75ml/liter

Yeast Nutrients

- You will see types of yeast nutrients on the market that can supplement a wort that is high in refined sugars or adjuncts.

- Di-ammonium Phosphate - This is strictly a nitrogen supplement that can take the place of a lack of FAN. (Free Amino Nitrogen)
- Yeast Hulls - This is essentially dead yeast, the carcasses of which act as agglomeration sites and contain some useful residual lipids.
- Yeast Nutrient or Energizer - The name can vary, but the intent is a mixture of di-ammonium phosphate, yeast hulls, biotin and vitamins. These mixtures are a more complete dietary supplement for the yeast and what I recommend.
- Servomyces (tm) - This product from Lallemand is similar to yeast hulls but differs by having a useful amount of rapidly assimilable zinc, which is an essential enzyme co-factor for yeast health. This product falls within the provisions of the Rheinheitsgebot.

Yeast Pitching Rates

- Wyeast website has a calculator for Pitching rates and Growth rates
- One vial or smack pack is good for a 5.5 gal batch of 1.048 or 12 Plato beer
- Calculation for the # of yeast needed for a beer:

(750,000) *(21000 milliliters of wort)*degrees Plato of the wort= # yeast needed

1.004 sg = 1 plato i.e. 1.060 sg =15 plato

21000 milliliters = 5.5 gal of wort

Example: 750,000* 21,000*15= 236,000,000,000 (236 billion of 2 smack packs/vials)

Yeast Starter Recipe

- Wyeast Recipe:
- 0.5 cup of DME(100 grams or 3.5 oz)
- ½ tsp nutrient
- 1 qt (1 liter) of water
- Mix water, DME and nutrient
- Boil for 20 minutes
- Pour into sterile container and loosely cover
- Allow this to cool to 70 F (lager or ale)
- Shake and Pitch yeast into starter
- Agitate frequently during the yeast growth stage
- Sanitation is critical so you do not contaminate the starter at any point after boiling.

Next Session

Session 3: September 20th, Market Garden Brewpub, 6:45 PM
Topic: Water.

Followed by comparison tasting.
Style of Beer : Hoppy Germans and Bocks???

Want more?

- Beer Judge Certification Program (bjcp.org)
- Saaz(Society of Akron Area Zymurgist)saazakron.ccom
- SNOBs (Society of Northeast Ohio Brewers) www.beersnobs.org (NOT snobs.org!)