Understanding Yeast

This document is designed to be an introduction to the importance of yeast health and proper fermentation technique. All information contained has been paraphrased from the book Yeast by Chris White and Jamil Zainasheff.

Countless sources indicate that yeast is perhaps the most important ingredient in the realm of beer making. Yeast is responsible for approximately 500 flavor and aroma compounds in a finished batch of ale or lager. Though often overlooked, a well selected and cared for yeast strain is the easiest way to begin making better beer; even more important than moving to all-grain brewing.

To take proper care of yeast, we must first understand what is most important to the health of our alcohol-producing friend…

Oxygen: Proper levels of oxygen in wort are rarely achieved with most of the methods we homebrewers believe to be sufficient. A typical ale or lager should have an oxygen concentration of about 8-10 ppm in solution to ensure maximum yeast health. Research has shown, however, that the shaking or splashing the typical home brewer uses will result in only 3 to 5 ppm in solution. Oxygen is also essential in a yeast cells ability to produce sterols and fats which are necessary for proper growth and pliability of cell walls. Without those two compounds, the yeast will suffer in growth potential, and be unable to reabsorb the undesirable off flavors resultant of fermentation.

Nutrients: A vast majority of nutrients and vitamins that are needed for a happy and healthy culture of yeast are readily found in brewers wort, but they account for a mere 75 percent of those needed for a perfect fermentation. Also required are phosphorous, sulfur, copper, zinc, iron, potassium, calcium, and sodium. Luckily for us homebrewers there are a few packaged nutrients available to us which supplement these crucial trace metals and nutrients. The usage rates indicated on their packaging won't always be correct for every batch of beer, but it is better to have them than to exclude them.

Temperature Control: Temperature control, or monitoring, is one of the most important things to consider when fermenting. If there is a problem in a batch that is not a result of infection, odds are it came from improper attention to temperature. Lower than recommended temps can cause fermentation to take longer to begin, and higher than recommended will result in the creation of higher concentrations of flavor compounds; often times including those that are not desired. As yeast creates heat during fermentation, you will want to pitch your yeast at no less than five degrees lower than is recommended for a particular yeast strain. The key after pitching is to ensure a consistent temperature – particularly within the fist 72 hours as this is when the majority of flavor compounds are

produced. Control near the end of fermentation is also vital. Yeast produce less heat when they are nearing the end of fermentation, so it is wise to raise the temperature of the batch nearer to that of the original pitch temp. Most commonly, a lack of heat at this stage will result in the yeast shutting down before proper attenuation levels have been reached. It may also result in yeast being unable to clean up undesired off flavors that naturally occur in fermentation. For tips and tricks related to proper cooling or heating systems for a batch of beer, there is wonderful information on home brew forums, or you may ask one of the employees at the store. For those unsure of making an expensive purchase (such as a fridge with a thermostat control), but have a spot in their dwelling that delivers consistent ambient temperature: it is best suggested to use yeast strains that work well in those temp ranges and to monitor the consistency of heat created during fermentation in that area.

The cycle of fermentation can be broken down into three distinct phases that showcase the importance of proper yeast health and pitched quantity at every stage.

Lag Phase (0-15 hours after pitch): At this stage of fermentation the yeast begin to absorb their supply of oxygen, vitamins, minerals, and trace metal compounds. The yeast also begin their growth cycle. Temperature at this stage of fermentation is crucial to yeast health and performance as they have not yet begun to produce their own heat.

Exponential Growth (4 hours to 4 days): This is the phase in which yeast begin the process of alcoholic fermentation. They ravenously attack available sugars and produce ethanol and co2 as a byproduct of their feeding frenzy. The yeast colony that was introduced into the batch will also begin to grow at an immense rate to properly and efficiently consume the simple sugars in wort. This stage accounts for nearly 90 percent of flavor and aroma compounds that will be present in the finished beer. Temperature consistency is of the utmost importance here.

Stationary Phase (3-10 days): In this phase the yeast will have ceased alcoholic fermentation, but their work is far from over. It is important to raise the temperature to that of the original pitching temp at this stage to ensure the yeast clean up after themselves. Compounds such as diacetyl, and acetaldehyde will be reabsorbed by yeast at this time, drastically improving flavor and aroma of the finished beer. At this time the krausen will fall back into the beer, which is one of the major indicators that fermentation has ceased.

The health of yeast is not the only thing that is important for optimum fermentation, the amount of yeast, or pitched quantity, also plays an enormous part in the quest for improved fermentation. See excerpt below.

As taken from Wyeast.

Pitch 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)

Now that we have discussed the importance of yeast health and proper pitching rates, we may now discuss the means by which both can be achieved with relative ease: a yeast starter. A starter is essentially a way to propagate a purchased quantity of yeast to maximize not only the health of the strain, but also to grow enough yeast to properly pitch into a batch of beer.

Why do I need to make a starter? Contrary to popular belief, a single vial, packet or satchel will not always contain enough yeast to ferment a given beer. A vial of white labs, or a smack pack from Wyeast, only contain 100 billion yeast cells, or roughly enough yeast to assuredly ferment a five gallon batch of beer that does not exceed an original gravity of 1.058. Conversely an 11.5 gram dry pack only contains 200 billion cells, or enough yeast to comfortable ferment a batch with an original gravity up to 1.065. Making a starter will help to grow enough cells from a purchased quantity of yeast, it will also assure the yeasts health and viability by the time it is pitched into the batch.

The equipment needed to make a starter: Erlenmeyer flask or growler. Spray bottle of sanitizer. DME. Water. Butane torch. Tin foil or a foam Stopper.

How big should the starter volume be? Use the immensely valuable, and free, resource known as Mr. Malty. This handy calculator will help you easily, and accurately decide the size of a starter and how many yeast cells will be needed for the specific batch of beer you are going to make. http://www.mrmalty.com/calc/calc.html

There are two common ways to make a starter that will maximize yeasts growth potential and health.

1. Stir Plate Starter. A stir plate is easily the most effective way to make a yeast starter. It offers the advantages of good gas exchange, immediate drive off of excess carbon dioxide, and it keeps the yeast in constant suspension. The only real disadvantage here is that a stir bar has the potential to increase the temperature of a starter by as much as five degrees. This will need to be taken into consideration to avoid temperatures in excess of 78 degrees, which is the maximum of temp ranges for yeast starters. Due to the constant intake of air, this style of starter will also quickly acclimate to ambient temperatures, so great care must be taken to avoid wild swings in temp. If done correctly, a stir plate starter can yield as much as three times the growth of a similar sized starter that is otherwise untouched during the duration of incubation.

2. Intermittent shaking of starter. If you do not wish to purchase a stir plate, this method can be very effective as well. A Starter that is shaken vigorously every hour will mimic(albeit not on as grand a scale) the positive attributes of a stir plate starter. However, the maximum amount of cell growth with this method will be a mere two times that of an unattended starter. The only drawback here is that it will also be susceptible, though not to as great an extent as a stir plate, to ambient temperature shifts.

The amount of DME that should be added into a starter will vary from batch to batch. You do not want to have too strong or weak a starter wort. A gravity of 1.030 to 1.040 has proven to be the best range for healthy and happy yeast growth. In order to achieve this, there is a simple rule of thumb. 1 gram of DME to every finished 10ml of starter wort volume. For instance a starter that will need to 1500 ml will take 150 grams of DME.

To learn the procedures for making a yeast starter it is best to talk with one of the employees at the store in order to discern what style of starter, and procedure, will best work for you.