# YEAST

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# Dry vs. Liquid Yeast

## Dry Yeast

Pros:

- Cheap
- No starter
- Longer shelf life
- Clean finish
- Higher cell count

Cons:

- Lack of variety
- The drying process causes re-hydrated yeast to produce undesirable flavor and aroma compounds. Significant difference in flavor and aroma as well as mouthfeel.
- Can’t harvest as well

# Dry vs. Liquid Yeast

## Liquid Yeast

Pros:

- Wide variety
- Only way to brew certain styles
- Better aroma and flavor profiles
- More intense and desirable flavor and aroma compounds
- Better mouthfeel and balance
- Pure, single strains of yeast with no contaminants

Cons:

- Expensive
- Requires starters
- Requires planning ahead
- Short shelf life
- Lower cell count

# Yeast Strains

Characteristics and differences

# Ales

- Top fermenting (mostly)
- Saccharomyces cervisiae
- Most perform best at 20°C (18-21°C)
- Can tolerate heat up to 35°C
- Go dormant at 12°C
- General categories:
  - Fruity
    - Ferment quickly
    - Lower attenuation
    - Clumpy
    - Create more diacetyl, esters, and fusel alcohols
  - Clean
    - Take longer to ferment
    - Higher attenuating
    - Less clumpy
  - Phenolic
    - Can also produce esters
    - Rarely produce diacetyl
    - High attenuation
    - Low flocculation
  - Hybrids
    - Clean flavor
    - Ferment slowly
    - Prefer lower fermentation temperatures

# Lagers

- Bottom fermenting (mostly)
- Saccharomyces pastorianus – result of contamination, 1500s
- Most perform best at 10-13°C
- Go dormant at 4°C
- Can ferment melibiose
- Produce fewer esters and fusel alcohols
- Keep more sulfur in solution
- Usually have low to moderate flocculation

- General categories:
  - Clean
    - Dry, cleaner flavor
  - Malty
    - More esters and sulfur

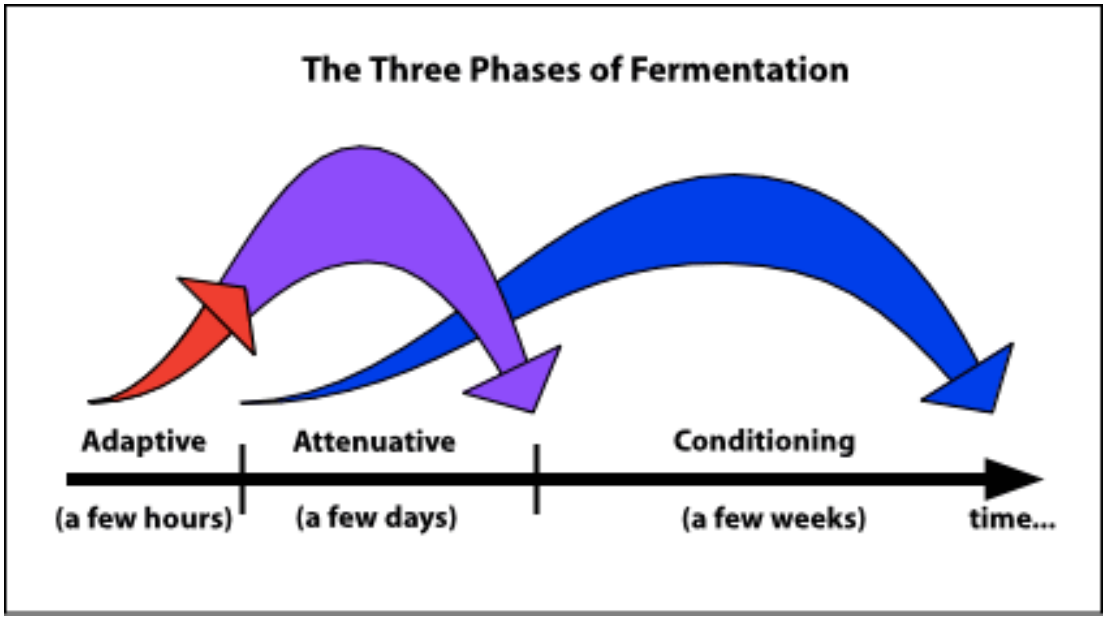
# Yeast Metabolism

How do yeast functions affect the flavors and aromas in beer?

500 different compounds are produced during this process.

# Yeast Metabolism

1. Lag or Adaptation phase
2. Exponential growth or Attenuative phase
3. Stationary or Conditioning phase



# Metabolic Phases

1. Lag phase: 0-15 hrs - 15-24 hrs
    - Yeast use up their glycogen reserves
    - Aerobic respiration
    - Increase cell wall permeability
    - Consume oxygen and nutrients
    - Fermentation is exothermic (may raise internal fermentor temperature up to 10°C)

# Metabolic Phases

2 Exponential growth phase: 4 hours - 4 days

- Sugars are consumed
- Yeast count grows
- Ethanol and CO2 are produced
- Esters and other by-products are released
- Krauesen builds

# Metabolic Phases

3. Stationary phase: 3-10 days
    - Growth slows
    - Yeast reabsorb diacetyl and acetaldehyde
    - Sulfur escapes
    - Yeast flocculates out

# Fermentation By-Products

Compounds & flavors produced/reduced by yeast during fermentation

For more, see: http://www.winning-homebrew.com/off-flavors.html and https://morebeer.com/themes/morewinepro/mmpdfs/mb/off_flavor.pdf

# Esters

Esters are volatile compounds that exhibit fruity characteristics.
Examples: banana, apple, solvent

Increased by:

- Low yeast pitch rate
- High fermentation temperature- 1-2°C can make a big difference in some strains.
- Oxygen

# Fusel Alcohols

Fusel alcohols are secondary alcohols produced during fermentation. They can add warming, hot, or solvent flavors and high levels promote headaches.

Increased by:

- Low yeast pitch rate
- High fermentation temperature and/or low temperature during stationary phase
- Inadequate nitrogen levels

# Acetaldehyde & Diacetyl

Acetaldehyde gives beer a green or green apple flavor/aroma. Precursor to diacetyl.

Diacetyl provides a buttery or butterscotch flavor, as well as adding a slick mouthfeel.

Increased by:

- Highly flocculant ale yeast strains
- High fermentation temperature
- Insufficient contact with yeast during stationary phase
- Too low a temperature during stationary phase

# Diacetyl Force Test

1. Heat a water bath to 60-71C.
2. Collect beer into two glasses and cover with foil.
3. Place one glass in the hot water bath. Keep the other glass at room temperature.
4. After 10-20 minutes, remove the beer from hot water bath and cool to room temperature.
5. Remove foil from each sample and sniff. If you smell butter in the heated beer only, the beer needs more time to condition on yeast. If you smell butter in both samples, there is a lot of precursor and needs more time to condition on yeast.

# Phenols

Phenols contribute spicy, medicinal, rubbery, smoky, or plastic aromas and flavors. They are less volatile than other by-products, so they will not go away.

Increased by:

- High fermentation temperatures
- Usually indicates a wild yeast contamination when unwanted

# Sulfur

Yeast produce many sulfur compounds during fermentation, especially lager yeasts. Flavors range from cooked cabbage/corn, burnt matches, farts, and rotten egg. Sulfur is usually driven off during fermentation by CO2.

Increased by:

- Lack of vigorous fermentation
- Cold crashing too early
- Packaging too soon
- Yeast stress: temperature fluctuations, high gravity wort, or a lack of certain nutrients

# Choosing a Yeast Strain

- What is the temperature range in your space?
- How highly attenuated do you want your beer?
- What beer style or flavors do you want to create?
- How clear do you want the beer?
- What is available?
- How versatile do you want it to be?

# Common Problems

Temperature control – lack of it

- Too hot, will produce:
  - Mutations
  - Off-flavors
  - Fusel alcohols
  - Yeast death
- Too cold, will cause:
  - Sluggish or stalled fermentation
  - Off-flavors

# Common Problems

## Fermentation

- No fermentation
  - Too cold or too hot
  - Dead yeast
- Stuck fermentation
  - Rouse the yeast
  - Raise the temperature
  - Re-pitch yeast
  - Transfer beer, harvest yeast cake, and re-pitch into a new fermentor

# Common Problems

## Off-flavors

- Wait until fermentation has completely stopped
- Let the yeast reabsorb by-products; do not cold crash
- Allow the beer to clear before packaging
- Phenolic - wild yeast contamination or too-high fermentation temperatures
- Diacetyl – incomplete fermentation; too-warm pitch temperature
- Acetaldehyde – incomplete fermentation; too-warm pitch temperature
- Yeast bite – autolysis. Too much yeast in bottles or beer in contact with yeast for too long (more than 4-6 weeks).

# Common Problems

Poor attenuation

- Too low a fermentation temperature
- Keep track of attenuation rate in other batches with same yeast for comparison and clues
- Change yeast to a higher-attenuating strain
- Too high: possible contamination

# Common Problems

## Carbonation: check priming sugar

- Undercarbonation
  - Condition bottled beer at 18-21°C for 2 weeks
  - Not enough airflow around the bottles
  - Pitching rate too low
  - Too low a conditioning temperature
  - Poor yeast health
- Overcarbonation
  - do a forced ferment test to find out what the lowest FG can be; if your beer is lower than this you know you have contamination.
  - Incomplete fermentation

# Forced Ferment Test

1. Take 80-100 mL beer sample right after pitching.
2. Place on stir plate at 27°C.
3. Measure specific gravity after all activity has stopped. This is the minimum gravity possible for the batch.

# Best Practices

Don’ts:

- Underpitch yeast
- Temperature swings
- Pitch too warm – most flavor compounds are made in the first 72 hours of fermentation. If you do pitch warm, finish warm to reduce by-products.

# Optimal Fermentation Regime:

- Pitch slightly below fermentation temperature (1-2°C) and allow the temperature to rise over 18-36 hours – results in healthier yeast, less cell membrane leakage, and a cleaner profile.
- Hold fermentation temperature steady till last third or quarter of fermentation. Then raise the temperature 2-5°C over the next day or two. This will:
  - Increase yeast activity
  - Increase attenuation
  - Reduce by-products
  - Drive off volatile compounds

# References


- White, C and Zainasheff, J. *Yeast: The Practical Guide to Beer Fermentation*. Brewers Publications, 2010.
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- Mosher, R. *Radical Brewing*, Brewers Publications, 2004.