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# Selecting Yeast Based on Strain Characteristics and Applying Environmental Conditions to Promote Flavor and Aroma Production

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Lesaffre B.U. in charge of development, marketing and sales of innovative and qualitative products and services for/to the **beer, wine, spirits** and **all other potable alcohol** industries worldwide.

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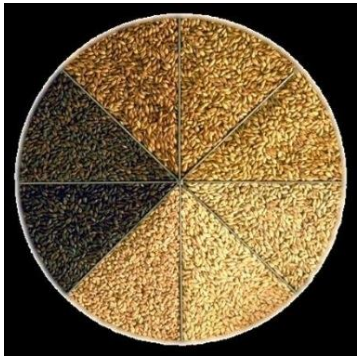
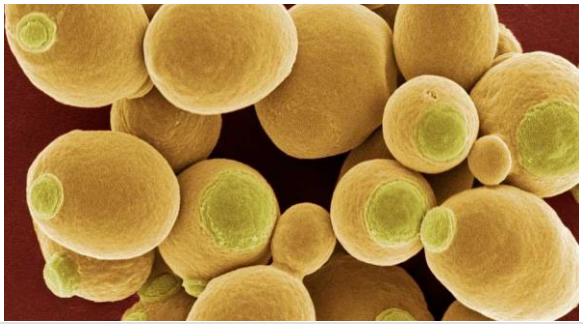
- For home brewers, currently, we offer
  - Safale
    - *US-05*
    - *S-04*
  - Saflager
    - *W-34/70*
    - *S-23*
  - Safbrew
    - *WB-06*
    - *S-33*
    - *T-58*
    - *Abbaye*
  - Red Star Wine Strains
    - *Pasteur Champagne (Blanc), Pasteur Red, Premier Cuvee, Cote Des Blanc, Montrachet*

# Brewers

- What do brewers do?
  - They BREW!



» Clean
» Select ingredients
» Mash
» Vorlauf/Lauter/sparge
» Boil and hop
» Sanitize equipment
» Cool
» **Pitch yeast**
» Clean ☹



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## Humans alone cannot "make" beer (alcohol)!

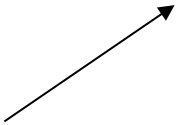
(if we could, we would get carded when buying candy)

We need the assistance, the help, the beauty of microorganisms to make beer or any other alcohol

**Yeast is a living organism and we need to <u>respect</u> that!**

# Yeast

- What do yeast do?
  - Reproduce and ferment
    - Convert sugar, nutrients, amino acids (proteins) and other compounds to produce:
      - More yeast
      - Alcohol**(s)** (ferment)



Heat
$CO_2$
Flavors/aromas
Other compounds

- Turn wort into beer by process of fermentation

# Brewers

- SO… what are brewers attempting to do?

- Create an environment for the yeast that will:
  - *Make the yeast happy*
  - *Drive characteristics that the brewer wants in his/her beer and exclude unwanted characteristics*
    - Produce alcohol**(s)**
    - Produce flavors and aromas
    - Produce other compounds
    - Carbonate
    - Leave a lot residual sugars or very little
    - Create something that is indistinguishable from someone else's beer or create something truly unique!

By stressing or not stressing the yeast

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Back to the title of this presentation…

Two Parts:

**Selecting Yeast Based on Strain Characteristics**

**and**

**Applying Environmental Conditions to Promote Flavor and Aroma Production**

# Selection

**Select yeast based on strain characteristics**

Home brewer's have many options:

- Dry yeast or liquid yeast?
- Ale yeast or lager yeast?
- American strains or foreign strains?
- One single strain or combinations of multiple strains?
- Wild yeast or cultured yeast?
- Beer yeast, wine yeast, cider yeast, distilling yeast or baking yeast?
- Cerevisiae or Bayanus or Brettanomyces?
- Just yeast or yeast and bacteria?

**It all depends on what the brewer is looking to make!**

# Selection (cont.)

- How to select yeast
  - Primarily, the brewer should select yeast based on a few criteria:
    - *Flavor and aroma **potential***
    - *Attenuation**
    - *Alcohol tolerance*
    - *Flocculation and sedimentation characteristics***

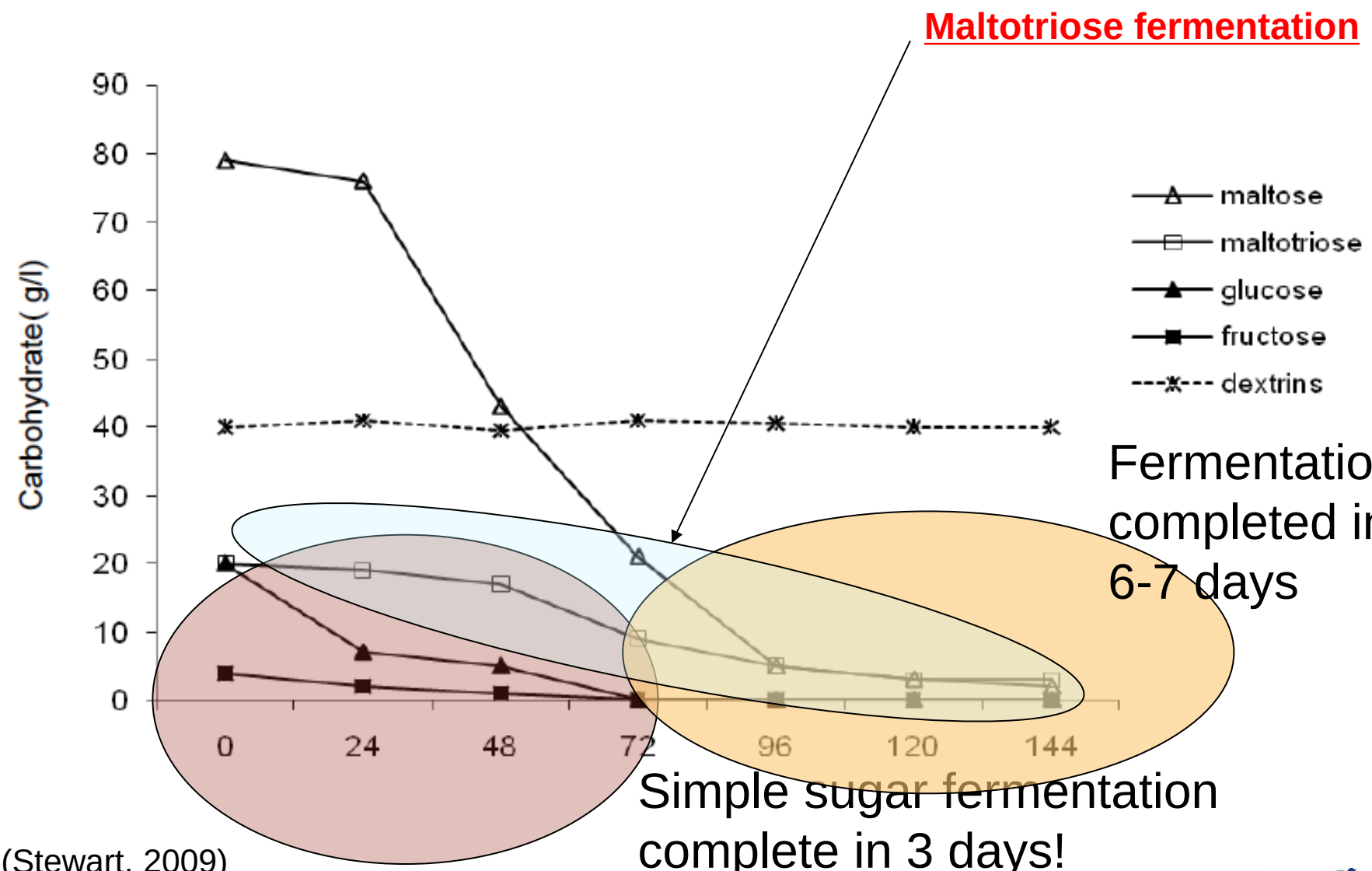
However, as this presentation suggests, the brewer can alter the environment to alter these characteristics

* and ** to be described shortly

# Attenuation

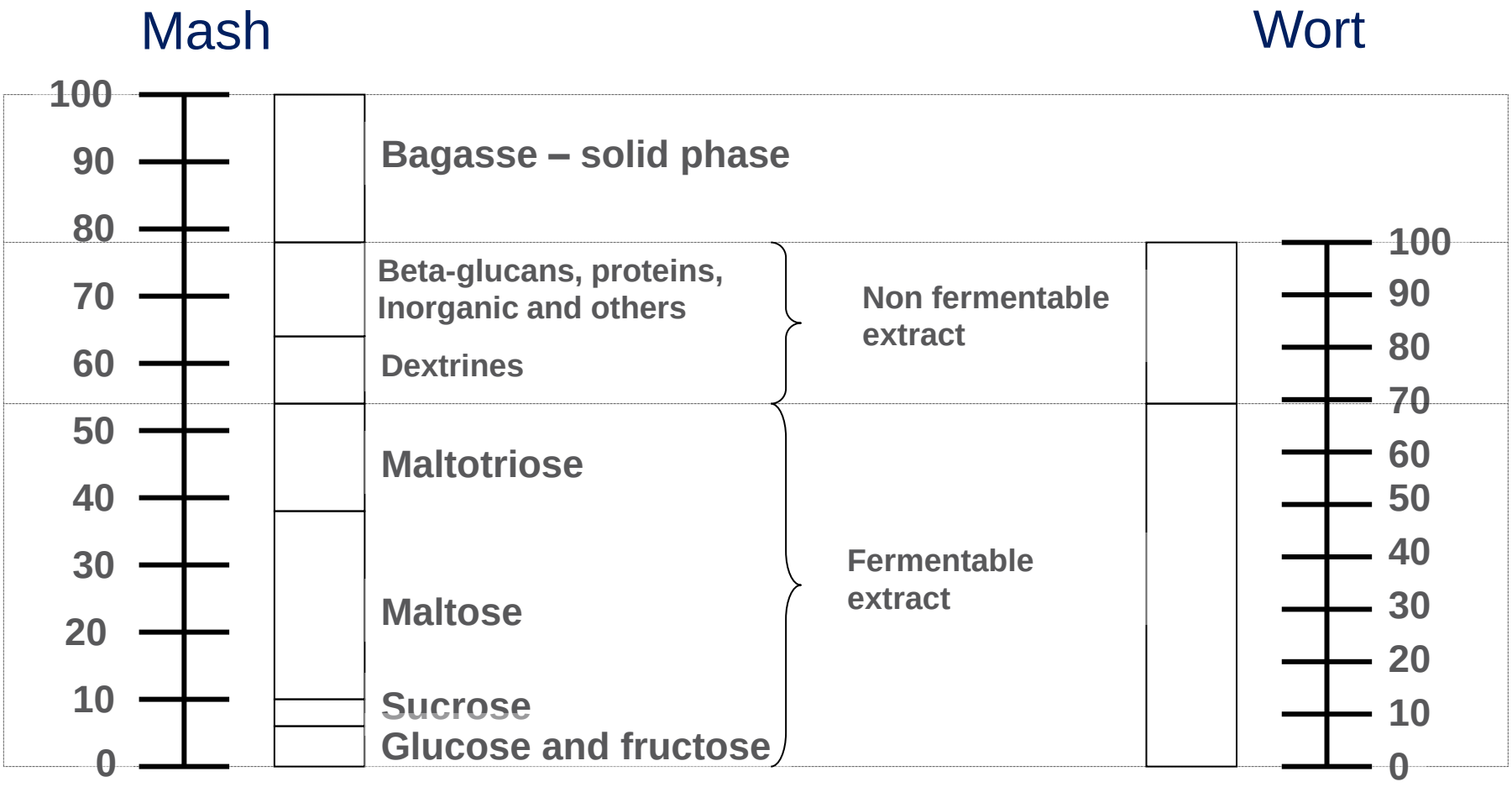
- Attenuation is misunderstood
  - Written as a percentage
    - *numerically, the number means nothing!!!*
  - Simply put, it is a way to compare two or more strains, side-by-side, in the exact same wort
  - The brewer selects the ingredients (which can include simple sugars ie. sucrose), as well as performs the mash (which can degrade starch to complex or simple sugars)
  - The attenuation is based **more on the brewing process and ingredients** than on the yeast strain due to yeast's sugar sequence of fermentation
  - **The attenuation percentage (comparably) is dependent on how well the strain can ferment maltotriose**

# Yeast sugar sequence of fermentation (typical all grain brew)



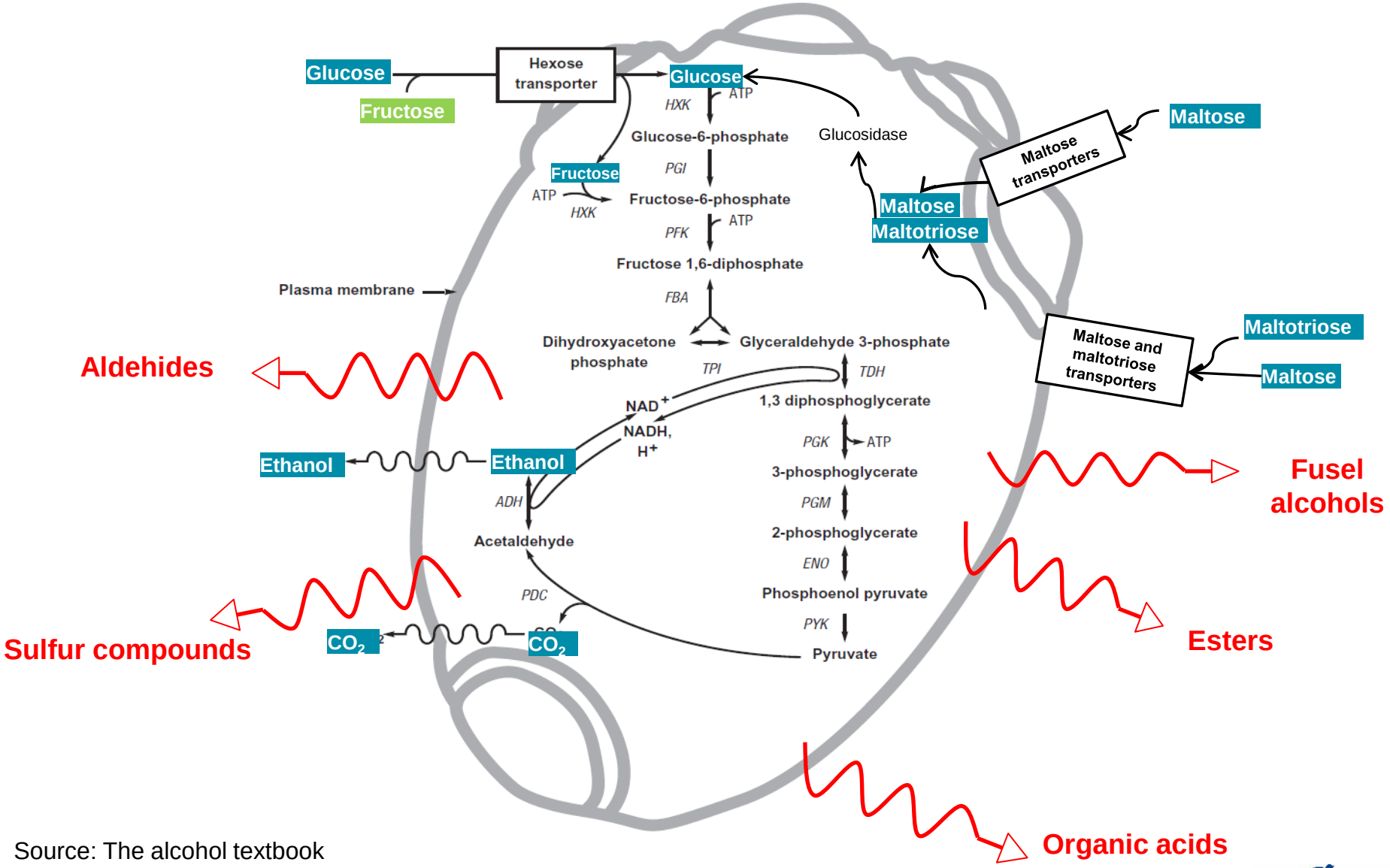

(Stewart, 2009)

# Composition of malt derived wort




Adapted from “Technology Brewing and Malting” (Kunze 1996)

# Why is that?




Source: The alcohol textbook

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| | Initial maltotriose (g/L) | Final maltotriose (g/L) | Consumption (g/L) | % of utilization | Potential alcohol (g/L) |
|---|---|---|---|---|---|
| US-05 13,5° | 12.71 | 2.88 | 9.83 | 77.3% | 5.02 |
| US-05 18° | 16.74 | 3.04 | 13.70 | 81.8% | 7.00 |
| US-05 17,5+5° | 16.48 | 17.69 | -1.21 | -7.3% | -0.62 |
| US-05 22,5° | 17.12 | 15.53 | 1.59 | 9.3% | 0.81 |

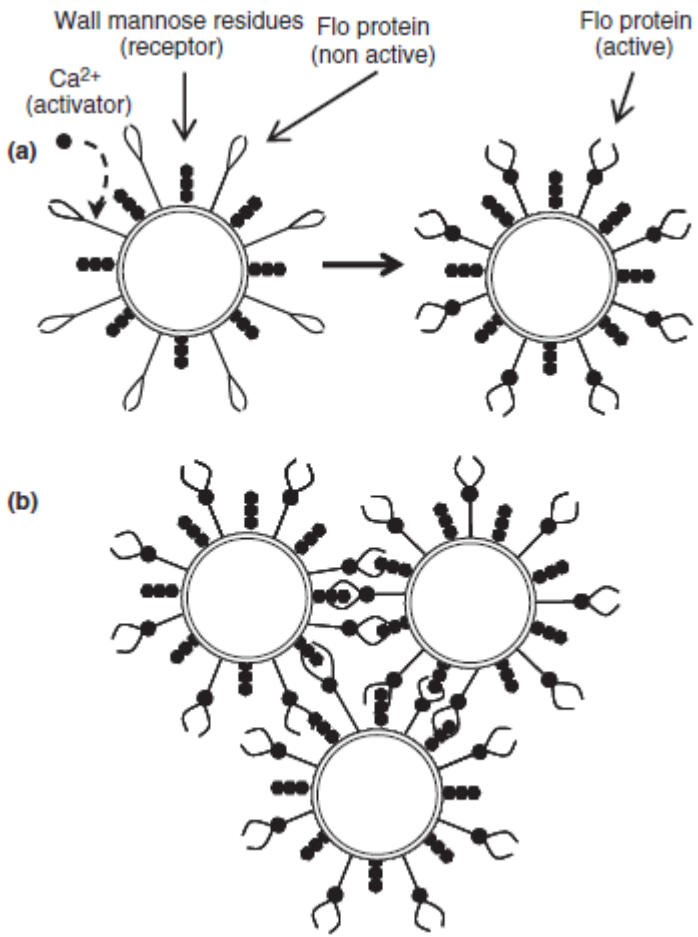
| | Initial maltose (g/L) | Final maltose (g/L) | Consumption (g/L) | % of utilization | Potential alcohol (g/L) |
|---|---|---|---|---|---|
| US-05 13,5° | 68.54 | - | 68.54 | 100.0% | 35.02 |
| US-05 18° | 93.23 | 6.21 | 87.02 | 93.3% | 44.47 |
| US-05 17,5+5° | 89.53 | 9.83 | 79.70 | 89.0% | 40.73 |
| US-05 22,5° | 114.74 | 3.88 | 110.86 | 96.6% | 56.65 |

| | Initial sucrose (g/L) | Final sucrose (g/L) | Consumption (g/L) | % of utilization | Potential alcohol (g/L) |
|---|---|---|---|---|---|
| US-05 13,5° | 4.23 | - | 4.23 | 100.0% | 2.16 |
| US-05 18° | 7.14 | 2.04 | 5.10 | 71.4% | 2.61 |
| US-05 17,5+5° | 53.02 | 1.15 | 51.87 | 97.8% | 26.51 |
| US-05 22,5° | 8.31 | 3.70 | 4.61 | 55.5% | 2.36 |

| | Initial monosaccharides (g/L) | Final monosaccharides (g/L) | Consumption (g/L) | % of utilization | Potential alcohol (g/L) |
|---|---|---|---|---|---|
| US-05 13,5° | 16.74 | - | 16.74 | 100.0% | 8.55 |
| US-05 18° | 23.18 | - | 23.18 | 100.0% | 11.84 |
| US-05 17,5+5° | 20.32 | - | 20.32 | 100.0% | 10.38 |
| US-05 22,5° | 26.57 | - | 26.57 | 100.0% | 13.58 |

| | Intial toalta sugars (g/L) | Final total sugars (g/L) | Consumption (g/L) | % of utilization | Potential alcohol (g/L) |
|---|---|---|---|---|---|
| US-05 13,5° | 102.22 | 2.88 | 99.34 | 97.2% | 50.76 |
| US-05 18° | 140.29 | 11.29 | 129.00 | 92.0% | 65.92 |
| US-05 17,5+5° | 179.35 | 28.67 | 150.68 | 84.0% | 77.00 |
| US-05 22,5° | 166.74 | 23.11 | 143.63 | 86.1% | 73.39 |

# Flocculation – another misunderstood concept




- Yeast flocculation can be defined as a nonsexual, homotypic, reversible and multivalent process of **aggregation of yeast cells into** multicellular masses (composed by thousands or even millions of cells), called **flocs**, **with the subsequent rapid sedimentation from the medium** in which they are suspended.

- The cells with the ability to form flocs are called **flocculants** and look like tufts of wool, while the cells that are not able to form flocs are usually known as **powdery**

E.V. Soares: J Appl Microbiol. 2011 Jan;110(1):1-18.

# Again, I got sidetracked…

## Back to yeast selection based on characteristics

Each strain has its own unique flavor and aroma profile as well as attenuation (maltotriose conversion capability) and alcohol tolerance

The flavors and aromas are **generally** relative to the types of beer they were selected for… over time

Beer, as we know it, has been made/recorded for 5000+ years and we have only known about yeast since the late 1860's thanks to Mr. Pasteur

The attenuation and alcohol tolerance were also selected over time

Ales generally produce more "yeast flavor and aroma"

while lagers are more neutral in flavor and aroma and produce more "yeast sulfur" (mostly due to the lagering process)

# General Characteristics

**Generally** ale strains are stronger in yeast derived flavors:

American ales

- Strong ester, slight citrus aroma and flavor
- Moderate attenuation
- Very slight sulfur

Safale US-05

English ales

- Slight to moderate ester
- Low attenuation
- Very slight sulfur

Safale S-04

*Belgian ales*

- Slight to strong ester
- Slight to strong phenol
  - » Possible "spicy" character
- High attenuation
- Slight sulfur

Safbrew T-58, Safbrew Abbaye

European ales (not including English and Belgian)

- Slight ester
- Moderate to high attenuation
  - » Possible phenolic (hefeweizen)
- Slight sulfur

Safbrew WB-06, Safale K-97

# General Characteristics (cont.)

Lagers are lower in yeast derived flavor in general but regionally:

German lager
- Clean, crisp, balanced
- Slight to moderate ester
- Slight Sulfur

Saflager W-34/70

Eastern European lager
- Clean
- Slight ester
- Moderate Sulfur

Saflager S-23

Northern European lager
- Clean
- Moderate ester
- Slight sulfur

Saflager S-189

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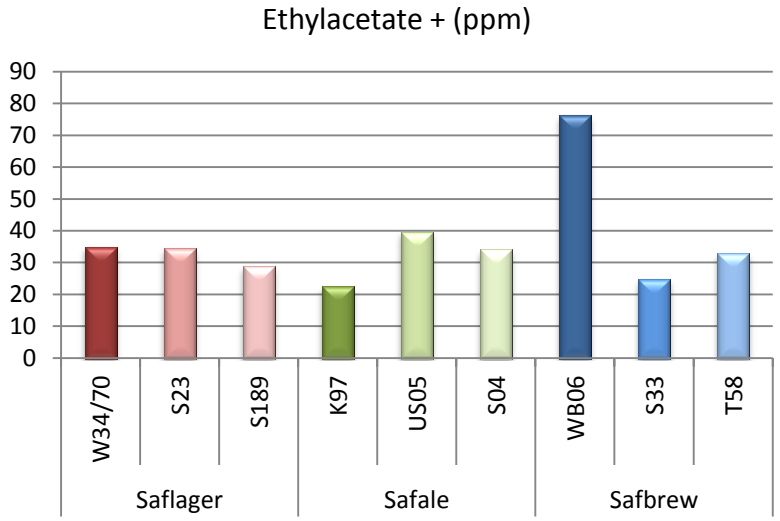
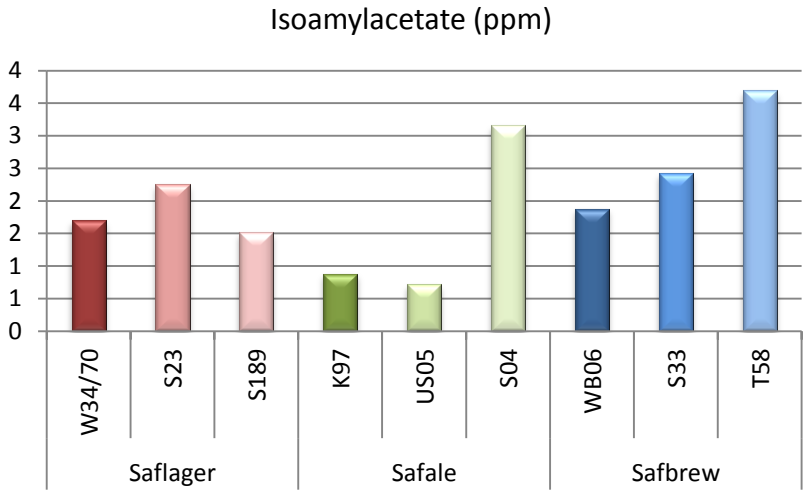
- When selecting yeast, it is **most** important to understand the possibilities of the flavor production, aromatics, precursor production, alcohol tolerance and attenuation

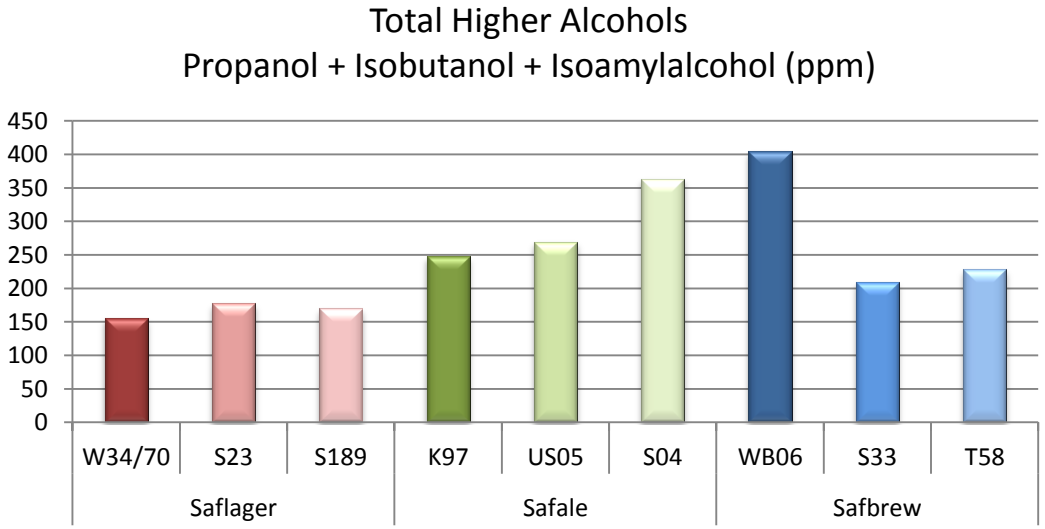
- Even when a supplier (such as Fermentis) lists a strain as neutral, the brewer can alter the process to influence the strain to produce more flavors or flavor precursors… and the opposite is true as well

- Some of the human recognized flavor, is interactions of different molecules over time, not strictly "yeast produced flavor"
  - Example:
    - *Young Barley Wine*
      - "hot" (alcohol)
      - Unbalanced
      - Short pallet
    - *Aged Barley Wine*
      - Smooth
      - Balanced
      - Lengthy pallet

# Difference in strains



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- Strain selection is similar to selecting an ingredient
  - The brewer bases this decision on the **possibility** of flavor impact
  - The brewer then dictates the amount, the addition time and how he/she will use the strain to promote flavor impact
  - Similar to the other ingredients, brewers can use more than one strain (co-inoculation)

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**Strain selection is and should be the starting point!!!**

# Applying Environmental Conditions to Promote Flavor and Aroma Production

**This is where things get REALLY complex…**

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- Flavors in beer
  - Malt flavors (base, pale, caramel, kilned, roasted, rye, wheat…)
  - Hop flavors (American hops, Noble hops, experimental hops, mash hop, dry hop, early kettle hops, late kettle hops…)
  - Water flavors (hard water {minerals}, soft water, brewing salt additions…)
  - "Adjunct" flavors (fruit, vegetables, spices, sugars…)
  - **Yeast flavors**

# Environmental Conditions

- The environmental conditions brewer's can alter
  - Ingredients
  - Mash profile
  - Fermentation temperatures
  - Pitch rate
  - OG
  - Strain(s)
  - Fermenter shape/design

- Yeast flavors (general)
  - Esters
  - Phenols
  - Acids
  - Alcohols
  - Residual sugars (not a yeast flavor, but yeast dependent)
  - Cider notes
  - Autolysis
    - *Sulfurs*
    - *Meaty notes*
    - *Aldehydes*
    - *Diacetyl*
    - *Soapy notes*

# Let's break this down

- Esters
  - A bonding between an alcohol and carboxylic acids
  - Generally more is produced at higher temperatures
  - Generally more is produced with lower aeration
    - *Acetal CoA can be in excess in yeast in low $O_2$ environments*
  - Generally more is produced with lower pitch-rates
    - *More cell growth*
  - Generally less is produced with increased fermenter pressure
  - Generally more produced in tall thin fermenter design, less in shallow
  - Differing thresholds
    - *Isoamyl acetate, human threshold is ~1.4ppm*
    - *Ethyl acetate, human threshold is ~33ppm*

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- Phenols
  - 4-vinyl-guaiacol (4-VG)
    - *Precursor is ferulic acid*
    - *Some strains have Pof(+) phenotype*
  - Increases with larger malt bill percentages of ingredients that have high ferulic acid content (wheat)
- Increases with ferulic acid rest (109-113 ° F) in mash profile

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- Alcohols
  - Most important
    - *Ethanol*
    - *Propanol*
    - *Isobutanol*
    - *Isoamylalcohol*
  - Generally produced due to stress on the yeast
    - *High OG*
    - *Unbalanced sugar composition*
    - *High fermentation temperature*
    - *Pitch rate (under or over pitching)*
  - Precursors to esters and other flavors/aromas

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- Residual sugars (residual extract {RE})
  - Primarily dependent on the strain selection (our friend attenuation)
  - Also, strongly dependent on ingredients used
  - More simple sugars, lower RE when comparing RDF
    - *Too much simple sugar can lead to a glucophilic stall in fermentation (stuck fermentation) leading to high RE (maltose and maltotriose)*

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# Off flavors produced

- Cidery
  - *Lack of yeast nutrition, increased amounts of simple sugars*
- Excess sulfur
  - *Typical in German and lagered beer but generally due to autolysis*
- Meaty notes
  - *Partially or fully autolyzed yeast*
- Aldehydes
  - *Produced naturally by yeast during fermentation and later reabsorbed during aging*
- Diacetyl (VDK)
  - *Produced naturally during cell growth due to lack of Valine and Isoleucine and thus cellular synthesis of both*
- Soapy notes
  - *Fatty acid degredation*
  - *Dead or inactive yeast degredation*

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- To summarize…
  - YEAST IS A LIVING ORGANISM, respect that!!!
  - Brewer's have the ability to select strain based on simple, but dynamic, criteria
  - There are many aspects that the brewer is in control of
    - *OG, temperature, ingredients, fermenter design, mashing, pitch rate…*
  - Yeast produce far too many compounds to talk about in one presentation
  - **You are trying to create the best environment for the yeast to thrive and produce the flavors you want!**

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- Now what???
  - Experiment
    - *You can find the best yeast(s) or microorganisms for your fermentation/beer*
  - Have fun
  - Do not be afraid to try something different or use a strain for something it isn't suggested for

- You are in control of your beer and production, do it your way and your way only!

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# Questions?

The floor is now yours!

Please visit www.fermentis.com and www.brewingwithfermentis.com

Visit our booth #410



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