Barrel Aging and Blending

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A Wee Bit of History

- Originally developed by the Celts (~350 BC) for storage and transport of bulk goods. Easy of use.
- Wooden barrels =storage vessel for beer until the mid 20th Century. Barrels were lined with pitch. This waxy substances purpose wad to protect against oxidation, contact with the microorganisms inside the pores of the barrels, prevent flavor impact from the wood to beer, and easy of cleaning.
- Lighter lagers gained popularity and stainless steel became preferred over wood barrels.
- Notable flavor and aroma attributes for barrel aged beer.
  - Vanillin - vanilla (aroma) and sweetness (flavor).
  - Tannins – drying, astringency, and some acidity.
  - Lactones - add unique spicy qualities – these will different with wood origins
- The primary use of barrels now is for spirit & wine production
  - Oak impart upwards of 200 chemical compounds to its contents
- Oak is the primary wood used in barrel making.
  - Strong, durable, pliability and tight grain composition

How to Choose Barrels

- Varieties of wood
- How the barrel was made – toast level
- Size of barrels
- Barrel condition
- Previous barrel use

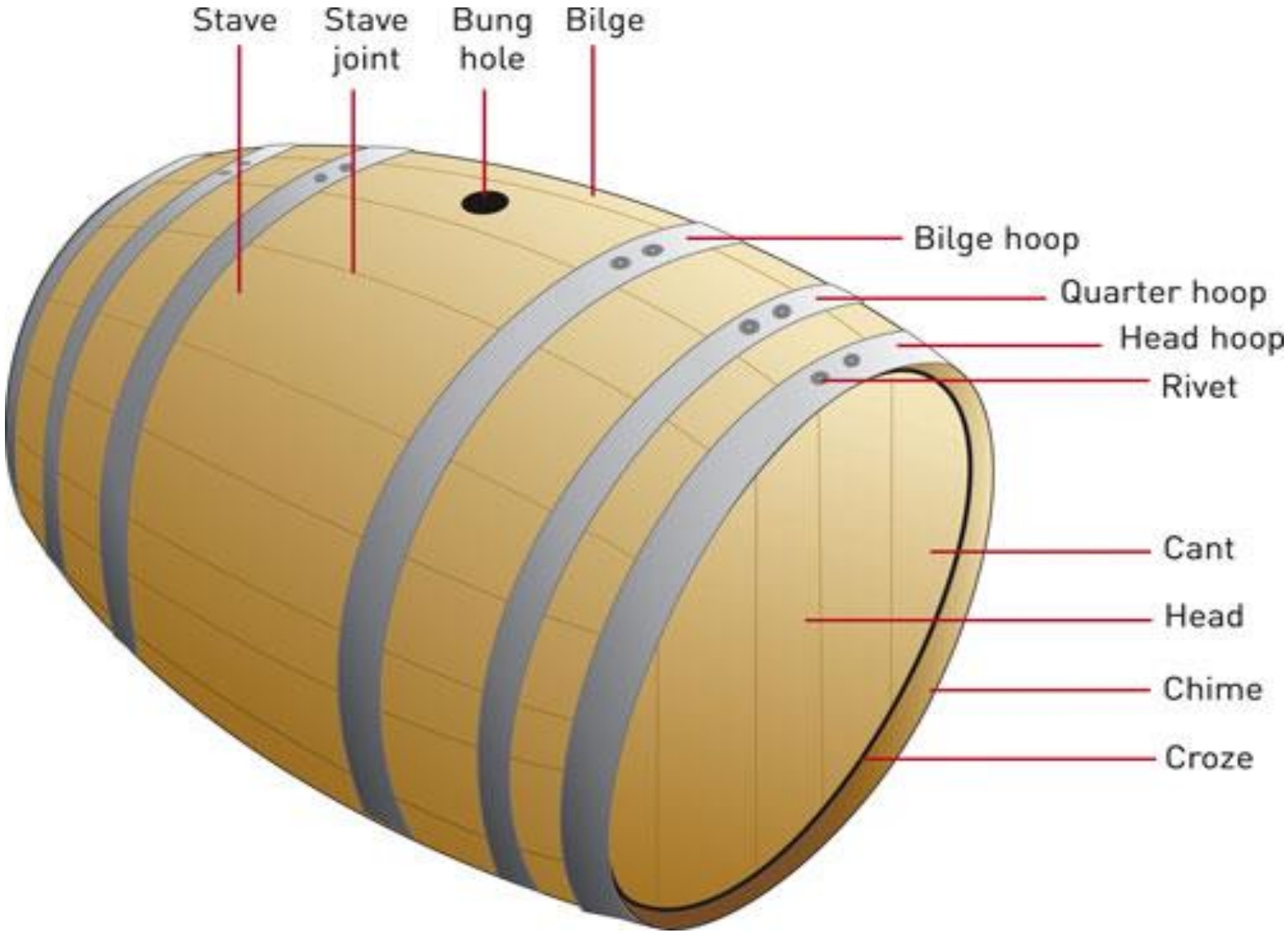
Types of wood

- **French Oak**
  - Highly porous
  - Tannin and sweet spice characteristics, as well as custard, butterscotch, milk chocolate. General distinctive of the forest the oak was harvested from.
  - Split Staves = smoother, tighter seal from stave to stave.
- **North American White Oak**
  - Heavy vanilla and a toasty/char character. Spice characteristics associated with harvest region
  - Used particularly for bourbon, whiskey, brandy, and rum
  - Sawn Staves = rougher edge and more surface area of wood to comes into contact with.
- **Hungarian Oak**
  - High spicy peppery characteristics, vanillin, roasted coffee, bittersweet chocolate, and fruit, cotton candy, and coconut

Cooperage Process

- Mature woods that are low sap, knot-free, and straight are traditionally chosen.
- Wood is "seasoned" for 24 to 36 months in the open air, in wood-yards or a kiln-dry method.
- Steam is applied internally and externally to the wood and slowly bent to achieve shape.
- Barrel heads are assembled using unbent staves and cut circularly Using coopering tools, riveted metal hoops are placed around the heads. Bung holes are drilled.
- Once entirely assembled, the exterior will be sanded, planed and polished. This is followed by a leak test/water check.
- Heat is applied to the staves and the surface is burnt hence the term charred.

Barrel = wooden staves bound by wooden or metal hoops



FIRE!

- Modification of structure and chemical composition of wood
- Light
- Medium
- High
- Heavy
- Toasting process takes 15-60 minutes and must be uniform & controlled

What does toasting do?

- More charred = more flavor impact
- Temperatures ranging from 250°F for light toast to 475°F for heavy toast.
- **Light** toast : coconut, cream, and white chocolate.
- **Medium** toast: coconut present but decreased, vanilla, caramel, coffee, toasted bread, milk chocolate, smoke, spice, and leather.
- **High** toast or medium plus: pronounced spicy, smoky, dry leaves, gunpowder, and black chocolate
- **Heavy** toast: intense smoky and possibly overly roasted character

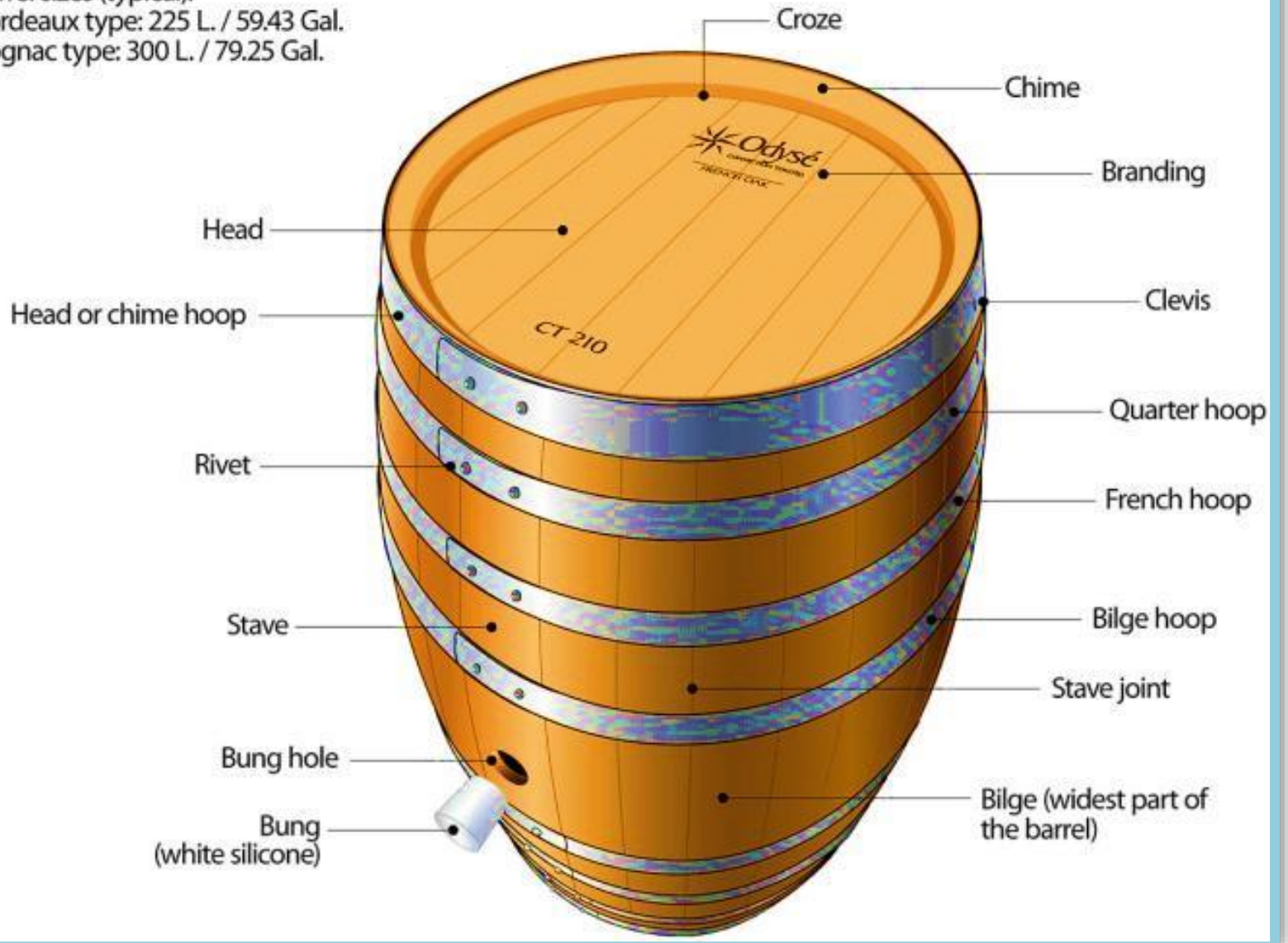
French oak: *Quercus petraea*
American oak: *Quercus alba*

CT: Convection Toasted

Hoops (galvanized steel)
American barrel: 6; French barrel: 8

Barrel sizes (typical):
Bordeaux type: 225 L. / 59.43 Gal.
Cognac type: 300 L. / 79.25 Gal.

Toasting levels (typical):



Size and Temperature Does Matter

- Sizes: ½ gallon– 160 gallon barrels (1L – 600L)
- Foeders (oak tanks)
- Relationship of Surface Area / Volume Ratio
  - Surface Area-Volume ratio gets smaller as the size of the barrel increases
  - Higher SA/V ratio (small barrel) = faster extraction
  - Faster extraction can mean less complexity
  - As the size of the barrel increases, less liquid actually comes in contact with the wood.
  - Small barrel have thinner stave and thus more oxygen diffusion.
- Temperature
  - Higher temperatures = faster extraction & fermentation

So Many Sizes

Major Constituents of Oak

- Cellulose, Hemicellulose and Lignin (monophenols)
- Tannins
- Lactones
  - American Oak highest concentration

Cellulose

- Pure glucose sugar
- Adhesive- holds wood together
- Inactive in maturation
- Some carbohydrates in high temperatures during toasting/charring
- These carbohydrates provide nutrient for microbes like *Brettanomyces* – breaks down into celloboise

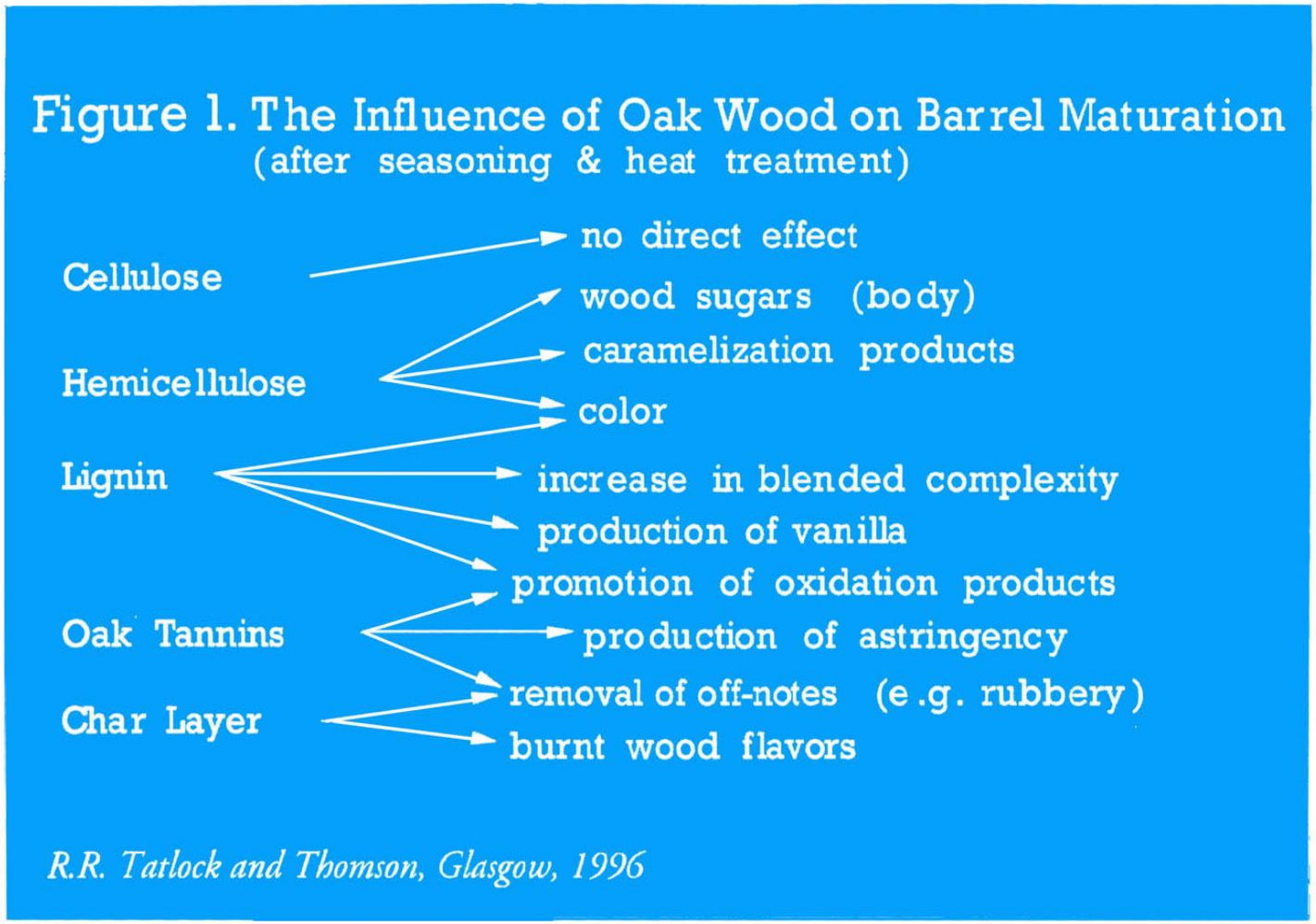
Hemicellulose

- Consists of simple sugars (glucose, xylose, mannose, galactose, etc)
- Breakdown of hemicellulose by heat begins around 140°C (284°F) and continues to temperatures above 225°C
- Effect the seasoning & toasting yields wood sugars (i.e. furfural, hydroxymethyl, maltol, etc)
- add body, toasty flavors and color. Notable flavor and aroma compounds are burnt & caramelized sugar.

Lignin and Monophenols

- Lignin consists of Guaiacyl and Syringyl
- The addition of heat from toasting breaks lignin down further into monophenols
- 25 different monophenols wood-aged beer
  - Medium toast produces phenolic aldehydes - Sweet vanilla, floral
  - Heavy Toast / Char produces steam volatile phenols - spicy, clove, smoky, burnt wood, medicinal
- Monophenol extraction can increase with increased surface area / volume, high ethanol, high temperatures, and low pH

Barrel Maturation



Oak Tannins and Lactones

- Oak tannins both astringent and bitter
- Tannins enabling oxidation
  - remove sulphur off-notes
  - promote color stability
  - Breakdown of lignin
- Lactones (2 natural isomers)
  - Sweet coconut, vanillin
  - Spicy, clove, celery, fruity

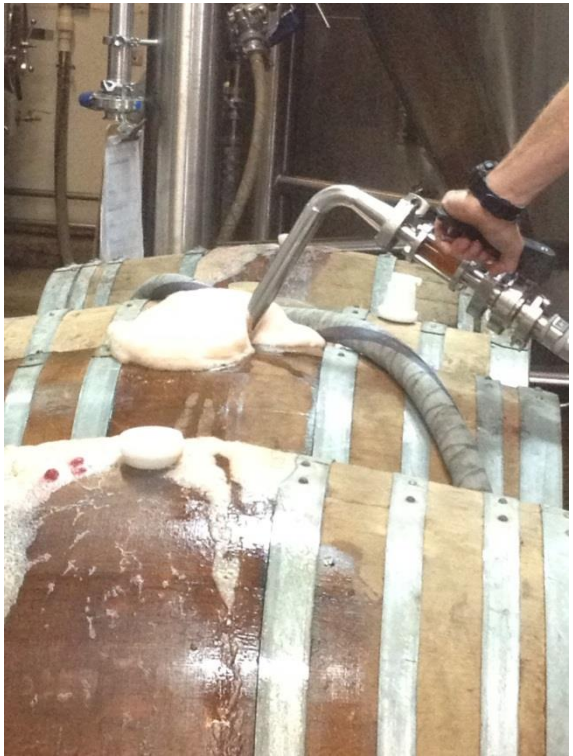
Previous Use

- Condition of the Barrel
  - Inspect for flaws
  - How long has it been empty
- What it was filled with
  - Fresh barrels are general not used for beer aging due to the strong wood characteristics
  - First time use typically is spirits or wine
  - Number of uses prior

Receiving Barrels

Filling Barrels

- Uncarbonated, warm beer
- Safety Concerns
- Sanitize equipment
- Barrel wand
- Barrel filling gun (squeeze lever)
- BullDog Pup Gas Racking Wand
  - Gas pressure to transfer.
  - Control flow (minimize agitation)



Storage

- Location
  - Safe
  - Temp fluctuations
- Labeling
  - Number follows barrel for life
  - Your records
- Racks
  - Different size barrels require different racks
  - How high to stack
  - Leakage

What will you use your barrels for?

- **FERMENTATION** –Unfiltered beer is placed into oak barrels to complete it's primary fermentation. The use of barrels in this way can bring a tannin, woody, spirit characteristics to the beer.

- **AGING**– Finished beers are aged for a undetermined or determined amount of time. Barrel aging can impart flavors of whatever was in the barrel previously (Spirits) as well as vanilla, smoke, spice, mocha, oak (or wood), fruit, coconut, etc.

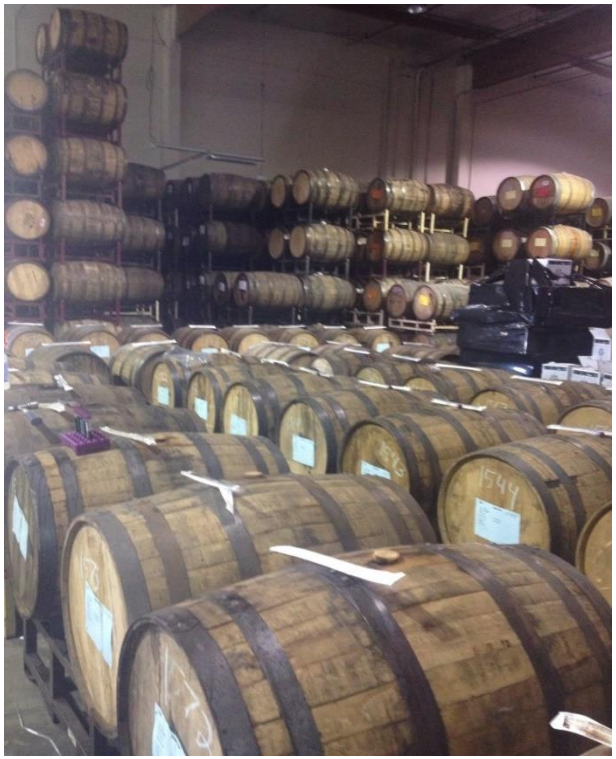
- **SECONDARY FERMENTATION** of Sour or Wild Beers – Finished beers are placed in barrels with secondary microflora (yeast/bacteria) to aged for usual an undetermined amount of time. French Oak wine barrels are commonly used. Barrels surfaces are rough and semi-porous and promote microbial growth

Common Questions

- Beer ages in barrels as long as it needs to, whether non-sour or sour. There is not a set or magically time that beer is ready.
  - Usually minimum of 6 months but as long as 2-3 years
- What goes in barrels?
  - Standard beer
  - Sour vs Non-sour
  - Special Recipes
  - Occasional “Oops”

Micro Testing

- Check every barrel of NON-sour beer for possible contaminates
  - Bacteria (WLD & HLP) and Wild Yeast (LCSM)

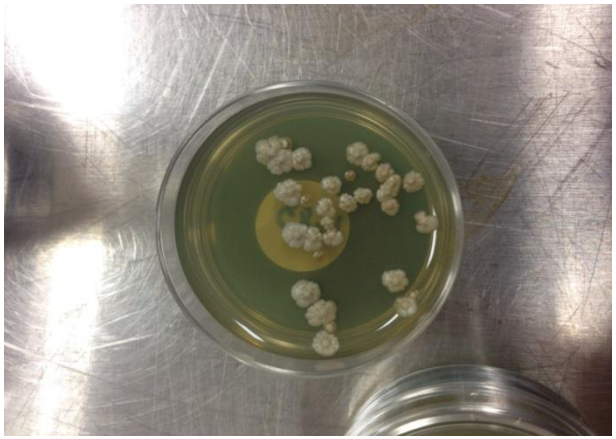


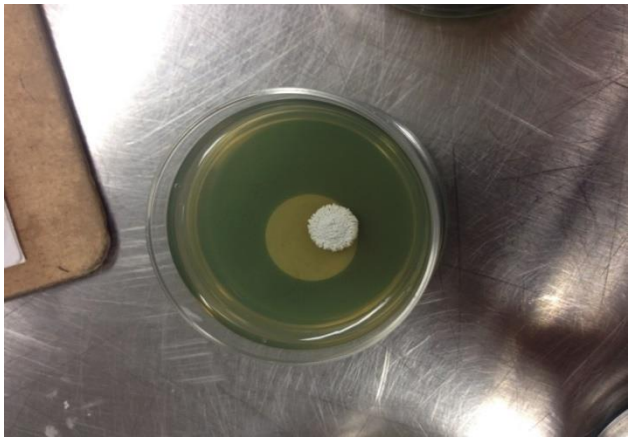
Hard to Detect and Identify

- Talk about a Needle in a Haystack: *Brettanomyces* do not distributed in tanks or barrels uniformly
- Incubation growth can take up to 14 days.
- Similar growth characteristics from different yeast can result in false positives.
- Plating will not detect viable but non-culturable cells (VNC). In other words they are waiting until conditions are favorable for growth

What if it is Micro Positive

- What is the contaminate?
- Is the flavor / aroma acceptable ?
- Do you trust a re-test
- Can you use barrel for blending
- Possible One Off in controlled environment





Care of Sour Barrels

- Fill with water (non-chlorinated), and citric acid and potassium metabisulphite, bung it tight.

- Empty, wash barrel thoroughly with hot water (180º F), let it dry without bung (~1 week), burn a sulphur stick inside barrel, bung tight

- Empty, wash barrel thoroughly with hot water (180º F). This also helps with leaking barrels and to remove any organic compound that has been left behind. Fill as soon as possible with next batch of beer! BEST PRACTICE

- NEVER reuse a barrel in which wine has turned to vinegar!

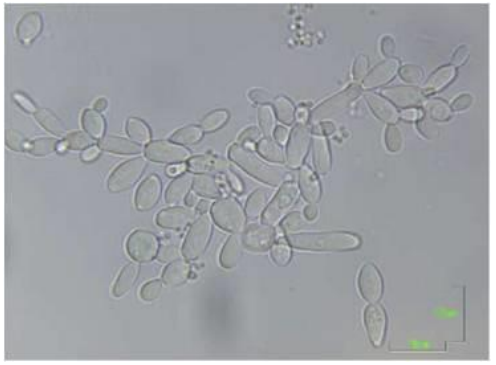
Adding Fruit

- Before or after beer?
- Beginning or after fermentation?

Adding some Culture to Barrels

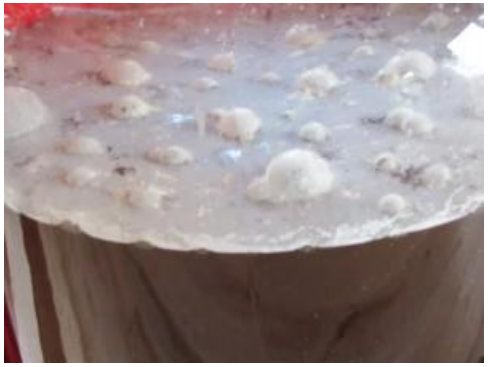
- Rough surface, semi-porous so some access to oxygen, wood sugars all help make barrels are “good” for microbial growth
- Common additions are:
  - *Brettanomyces*
  - *Lactobacillus*
  - *Pediococcus*

“British Brewing Fungus”

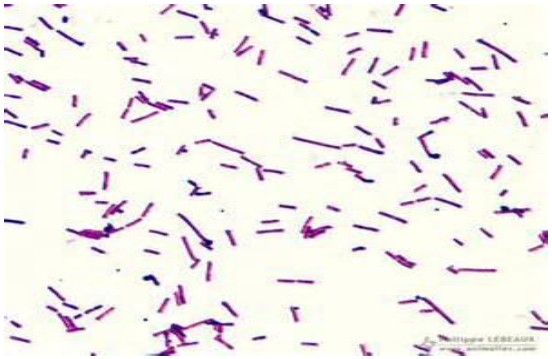


- Genus *Brettanomyces* synonymous with *Dekkera* (Loureiro & Malfeito-Ferreira, 2006).
  - Anamorphic (asexual) vs. Telemorphic (sexual)
- Opportunistic – metabolizes unfermentables like cellobiose, trehalose and ethanol.
- Common Strains include B. bruxellensis, B. lambicus, and B. claussenii. There are so many new species and subspecies evolving and being archived.
- Invasive up to 8 mm into barrel wood – It’s there to stay
- Growth will slow once the beer reaches 3.4 pH
- Production of “Brett” growth and additional characteristics can be restarted by the addition of glucose and/or fructose…….FEED THEM!

What's that on the top?



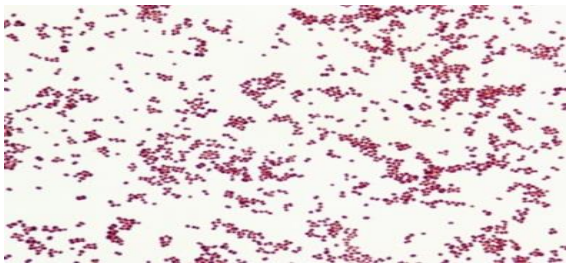
- **PELLICLE**: (it's a biofilm) forms when the yeast (or bacteria) aggregate into a solid substrate. This colony of microorganisms may be protecting themselves against competition or toxins. If its *Brett*, then they can make use of atmospheric O2.
- Studies have shown when sugars have been depleted there is a higher formation of the pellicle.
- Leave the pellicle in tact.
- Pellicle can form in the bottle or kegs as well.



Lactobacillus (aka Lacto)

- Gram positive rods, catalase negative
- Facultative anaerobe – prefers no oxygen, but tolerate its presence.
- Hop tolerant
- Inhibited growth as alcohol percentage increases
- Convert Lactose and other sugars to lactic acid and produces CO2
- Lactic acid production is thought of as tart and tangy more than sour but too much may make your beer unpleasantly sour
- Ropiness / turbidity can be produced by some species
- Diacetyl can be produced by some species.
- For the most part, Lactobacillus will cease to reproduce at a pH of around 3.8- that is pretty sour though!
- Lactobacillus important in Flanders and a also Lambics.

Pediococcus (aka Pedio)



- Gram positive cocci, catalase negative
- Convert Lactose and other sugars to lactic acid but produces no CO2.
- Diacetyl production typical
- Inhibited growth as alcohol percentage increases.
- Facultative anaerobe – prefers no oxygen, but tolerate its presence.
- Ropiness / turbidity is produced “Sickness”. This adds to the mouthfeel of the beer.

Acetobacter

- Gram negative, catalase positve
- Strict Aerobic
- Ethanol is converted to acetic acid in the presence of oxygen.
- Not really a good thing and too much is definitely not good = vinegar
- Flemish styles can have *Acetobacter* characteristics.
- *Acetobacter* is not added to beer.
- Top off barrels

Sampling

- Using sanitary technique spray head area and equipment with Ethanol (food grade)
- Drill hole near bottom of barrel head using a stainless steel drill bit
  - Positive pressure
  - Not disturbing pellicle
- Plug with stainless nail

Tastings Records

- Keeping records of everything you taste
  - Barrel #
  - Beer Style
  - What is it inoculated with / cultures / fruit
  - Time in barrel
  - Flavor & Aroma
  - Possible Uses

Tasting and Blending

- High Acid? Ethyl Acetate? Diacetyl?
- Does it need to sit longer? More fruit? Cultures?
- How do the samples combine?
- How will it taste carbonated?

Blending

- Barrel is in charge of when it is ready
- No Magic Formula
- Blending barrels together to attempt consistency
- Blend barrel beers for unique flavors
- Off aromas/flavors combine to make perfection
- Each Barrel = A Flavor Ecosystem
  - Barrel to barrel variation
  - Different concentrations of wild yeast and bacteria will yield different ratios of attributes. This is why every barrel will taste different

Prepackage Sampling

Fill and Start Over!