Brewing Sour Beer, Intentionally

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Common Sours

- Lambic & Gueuze
  - Cantillon, Liefmann's
- Flanders Red & Brown
- American Sour
  - ie Russian River, New Belgium, Jolly Pumpkin
- Some Saisons
- Berliner Weiss

Microorganisms

- Brett is an oxidative yeast; the production of acids is an oxidative process.
- There are many strains of *Brettanomyces*.

  Common Strains are:

  B. anomalous

  B. bruxellensis

  B. lambicus

  B. claussenii
- *Brettanomyces* can also metabolize the sugars (cellobiose) from the oak barrel.
- *Brettanomyces* can even metabolize complex polysaccharides (dextrin)

Brettanomyces (yeast 5-10 µm)

- Super attenuating
- Susceptible to pH lower than 3.4
- Brett forms a pellicle- a lumpy white film that coats the top of the beer during fermentation. The yeast cells flocculate into chains that can float on the top of beer making use of atmospheric oxygen, thus, Brett is an oxidizing yeast. The pellicle will form in the fermenting vessel (porous or non-porous) and help guard against oxidation during the long aging / fermentation time. The pellicle also guards against acetobacter
- Avoid piercing the pellicle

Pediococcus (bacteria 0.5-5.0µm)

- Produces loads of lactic acid
- Metabolizes glucose into lactic acid without producing carbon dioxide
- Evolves diacetyl
- Gram-positive, in the family of *Lactobacillaceae*
- Normally considered a beer or wine spoiler

Pediococcus (bacteria)

- Produces a “slimy” or “ropy” character that is composed of carbohydrates, acids, and proteins
- This comes out after 3 to 4 months
- Sick beer is more acidic
- Beer can be sick twice

Lactobacillus (bacteria)

- Lactobacillus plays a major role in Flanders type beers, not so much in true Lambics.
- Metabolizes sugars aerobically and anaerobically
- Lacto is lighter on the palate and is more tart and tangy than sourness derived from Pediococcus.
- Lactobacillus delbrueckii produces both lactic acid as well as carbon dioxide as a by product of fermentation.
- Lactobacillus will cease to reproduce at a pH of around 3.8
- Like most gram-positive bacteria, the presence of certain hop acids will slow the growth of most Lactobacillus.

Acetobacter (bacteria)

- Produces acetic acid (vinegar) by oxidizing ethanol to acetic acid.
- Many beer souring microorganisms find oxygen or the production of alcohol during fermentation to be detrimental to their viability. Acetobacter requires oxygen to convert alcohol to a acetic acid.
- Insects like fruit flies and bees can carry acetobacter.
- Not an organism you add, it comes from the vessel

Wood

- A brewer making funky beers in wood fights to keep bugs and critters at bay, while never actually killing them.
- Wood will never be totally clean as it is a porous surface, French oak more so than American
  - As the size of the barrel increases, less liquid actually comes in contact with the wood.
  - The smaller the barrel the thinner the barrel stave is, the thinner the stave the more oxygen diffusion you'll have going on in the cask.
  - The surface to volume ratio gets smaller as the size of the barrel increases

More Wood

- Brettanomyces will use oxygen during barrel aging, but, will form a pellicle to protect the beer from too much oxygen.
- Oxygen promotes the growth of Acetobacter and retards the growth of Pediococcus & Lactobacillus. Higher levels of oxygen will cause acetic acid and ethyl acetate to be produced more quickly than lactic acids.
- Too much acetic acid and you'll have vinegar.
- PS Don't clean your barrels with modern brewing chemicals

Oxygen Diffusion into Different Vessels

Type	Volume (Gallons)	O2 / L / Year
Rodenbach Wooden Tun (Large)	5,280	.53
Rodenbach Wooden Tun (small)	3,168	.86
Wine barrel	79.2	8.5
Glass Carboy w/ silicone stopper	**5.3**	**17**
Small Homebrewer's Barrel	**10.6**	**23**
Homebrew bucket	**5.3**	**220**

Thanks to Raj B. Apte who contributed this information to Jeff Sparrow in his book Wild Brews.
If you don't own Wild Brews and you want to brew sour beers, it is the best book to learn from!

Brewing

- Belgians use a thick/turbid mash (for Lambic) - low water ratio
  - Can result in a less complete mash conversion
    - MORE STARCH
  - We want sugars leftover for the “wild” microbiota
- Use of unmalted wheat (especially in Lambic)
  - Provides different nutrition sources for the “bugs”
- Old hops/low amounts of hops
  - Not looking for the character, or too much preservation
- Ferment primary on *Saccharomyces* -add “bugs” after yeast flocculates

Spontaneous Fermentation

- Hot wort is pumped to a cool ship and allowed to cool exposed to the air

Practicalities

- Use oak chips as microbiota harbor
- Separate your normal brewing equipment from you “dirty” equipment - hoses, gaskets, porous fvs
  - Mark the dirty things with red tape
- Don’t rack to a secondary fermenter
  - Leave the primary trub - nutrition for Brett
- Don’t disturb the pellicle
- Add Brett before Pedio or Lacto
- Don’t disturb spider webs…

Practicalities

- Bottle at a specific gravity of 1.010
  - The beer will be carbonated and not “sick” in about 4 months
  - A pellicle may form in the bottle
- The beer will tell you when it’s ready, don’t rush it, and don’t be afraid to blend

Feeling Fruity?

- Recommend against fresh fruit
  - Pesticides, waxes, undesirable microbes
- Use Frozen, Canned/Puree, Flash heated
- Common Fruits
  - Cherry, raspberry, currant, peach

Barrel Care

- Keep barrels wet, preferably with beer
  - Vintners will use metabisulfite
  - Vintners and some Distillers use sulphur smoke
- Cleaning- avoid harsh chemicals
  - Hot water works well, 180 F
    - helps to soak the barrel as well
  - Flying Dog uses clean steam
- Toothpicks, Garlic, Chalk

Conclusion

- Use normal CIP procedures for primary beer production - control your level of contamination
- Use commercially available products
  - Wyeast has an array of bacteria and “wild” yeast
- Be PATIENT - these microbes work slowly
  - Monitor pH, specific gravity, and taste (sidebar)
- Brett should go in before bacteria
- Bacteria like it warm (75 F+)
- These microbes will produce different metabolic byproducts under aerobic & anaerobic conditions

Sources

- “Wild Brews” Jeff Sparrow
- Vinnie Cilurzo, Russian River Brewing Co.
- Siebel Institute of Technology
- “Farmhouse Ales” Phil Markowski

The Science, cause someone will ask

- *Pediococcus* and *Lactobacillus* produce lactic acid from hexose sugars through the Embden-Meyerhof pathway and from pentose sugars by the 6-phosphogluconate/phosphoketolase pathway
  - E.M. pathway is a common type of Glycolysis (the converion of glucose into pyruvate)
    - The energy released during this process is used to from ATP and NADH which are high energy compounds
    - This is essentially how these microbes “eat”/survive