The Influence of the Mash on Sour Beer Production

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Overview

- Carbohydrates
- Mash pH
- Esters
- Phenols
- Body & Mouthfeel
Your First Sour Beer

- Parameters:
  - OG = 1.040-1.060
  - IBUs < 20
  - SRM < 25
- Brew your favorite qualifying clean beer recipe
  - English brown, Kölsch, American wheat, Scottish 60/- etc.
- Pitch into primary:
  - Standard brewer’s yeast
  - Commercial souring blend (e.g., WY3763, WLP655)
  - Bottle dregs from two unpasteurized sour beers
Standard vs. Purpose-Brewed Wort

- **Standard wort**
  - Easy!
  - Split batches

- **Purpose-brewed**
  - Additional influence over:
    - Acidity
    - Fruitiness
    - “Funkiness”
    - Body
Starch Conversion

- Unfermentatable by what?
  - Above three glucose chains (maltotriose) for brewer’s yeast, also lactose and other with beta-bonds (e.g., glycosides)
  - Above nine glucose chains for many *Lactobacillus*, and *Brettanomyces* strains (limit of alpha-glucosidase)
  - Some *Pediococcus* species are capable of fermenting starch!

- Carbohydrates
  - Starches
  - Dextrins
  - Sugars
Effect of Additional Dextrins

- Lactic acid bacteria
  - More carbohydrates = more potential acidity
  - Heterofermentative vs. homofermentative strains
  - Some commercial *Lactobacillus* strains are lacking...

- *Brettanomyces*
  - More carbohydrates = more CO$_2$ and ethanol
  - More esters anecdotally
  - No additional “funkiness”
    - 100% *Brett* fermented beers
Reducing Initial Attenuation

- Mash hotter
- Pitch a less attenuative brewer’s yeast
- Crystal/caramel malts in mash
  - Nilo Bortolotti’s experiment: 50% crystal malt reduced attenuation by 3% with C10, 11% with C40, and 13% with C120
- Lower water-to-grain ratio
  - Kai Troester’s experiment: no change between thick (1.21 qt/lb) and thin (2.37 qt/lb) mashes
- Long boil
  - Ankita Mishra’s experiment: extending a boil from 30 min to 120 increased FG by .001
Unmalted Grains

- Gelatinization/Gelation
  - Not gelatin!
- Raw grains
  - Cereal mash
  - Turbid mash
- Pre-gelatinized
  - Flaked
  - Torrefied
  - “Instant”
  - Minimal impact on fermentability
Influence of Mash/Wort pH

- Logarithmic scale
  - 3.0 100X more acid than 5.0
- Low pH can disrupt starch conversion
  - Cheater’s turbid mash?
- Inhibit *Enteric* bacteria (spontaneous)
  - pH < 4.5
- Prevent protein breakdown by *Lactobacillus*
  - pH < 4.5–4.8
- Alters ester production by *Brettanomyces*
Lowering pH Pre-Fermentation

- Acid malt
  - Up to 20%
- Refined lactic acid
- Sour mashing
  - Highly variable
  - Not advised
- Sour the wort instead!
Acids to Esters

- Lactic acid – many sources
  - Ethyl lactate – fruity
- Acetic acid – *Acetobacter/Brett*
  - Ethyl acetate – fruity to solvent
- Caprylic – buckwheat/autolysis
  - Ethyl caprylate – pineapple
- Butyric – kombucha/parsnips
  - Ethyl butyrate – tropical
- Be careful, acid to ester conversion isn’t always complete!
Influence of Phenols

- 4 vinylguaiacol (4VG)
  - Classic clove “spiciness” of hefeweizen and Belgians
- 4 ethylguaiacol (4EG)
  - Smoky-barnyard flavors of *Brettanomyces*
  - Converted from 4VG
- 4 vinylphenol (4VP) and 4 ethylphenol (4EP)
  - Barnyard, medicinal, and Band-Aid
Controlling Phenols

- Wheat malt increases ferulic in wort
  - Despite containing less than barley
- Ferulic acid rest
  - ~113°F (45°C) for 10-15 minutes
  - Converted to 4VG by POF+ brewer’s yeast
- Limit polyphenol extraction
  - Crush
  - Sparge (watch temperature and pH)
  - Use 2-row base malt
Body and Mouthfeel

- Why are wild beers so thin?
  - Lack of residual dextrins
  - Less glycerin (100% Brett especially)
- Remedies?
  - Additional protein
    - High-protein adjuncts
      - Rye, oats, spelt, and quinoa
  - Higher chloride water (100-150 PPM)
  - Beta-glucan, soluble fiber (maybe...?)
  - Be mindful of carbonation
Minimize Funk and Acidity

- Minimize funk
  - No wheat malt
  - Straight to saccharification rest
  - Use a non-phenolic brewer’s yeast (e.g., English, American, lager)
  - Brettanomyces anomalous (AKA B. claussenii) – or no Brett!
  - Rack to secondary after fermentation
    - Optional: cold crash, fine, or filter
  - Force carbonate

- Minimize acidity
  - Saccharification rest at 146-148°F (63-64°C)
  - Pitch highly attenuative brewer’s yeast
  - Lactobacillus delbrueckii, L. buchneri
Maximize Funk and Acidity

- Maximize funk
  - Add wheat malt
  - Start with ferulic acid rest
  - Pitch a phenolic brewer’s yeast strain (e.g., Trappist, hefeweizen, saison)
  - *Brettanomyces bruxellensis* (AKA *B. lambicus*)
  - Sour in primary fermentor
  - Bottle condition

- Maximize acidity
  - Saccharification rest at 158-160°F (70-71°C)
  - Pitch less attenuative brewer’s yeast
  - *Pediococcus, Lactobacillus brevis*