DO TRY THIS AT HOME!
Emerging commercial brewery techniques
that you can apply to your homebrew
Kate Stebenko, Jack’s Abby Craft Lagers
Springdale Barrel Room
June 21, 2018

Temperature Effects
STRAIN MATTERS!

Lager

W-34/70
S. pastoranus
“Bottom fermenting”

- Coldest fermentation
  - Caves, cellars
  - Distinct lagering phase
  - Steam beer
- Limited ester production
  - Intentional
- Limit yeast flavor
- Flocculation
- Highest pitch rate
IPA

- Wide range of esters
  - Very strain dependent
  - NEIPAs usually use a Conan variety
- Highly influenced by temperature
  - Warm = more esters
- Diacetyl production
 - Differing flocculation
  - Haze???
- Hopping effects
  - More on that later

US-05 (Chico)
Burlington Ale (Conan?)
LalBrew New England Ale
S-04?

Belgian

- Warmest fermentation
  - Free rise
- Most oxygen (warmer liquid needs more gas)
  - Pure oxygen if you can
- Lowest pitch rate
  - **Stress the yeast!
- Stressed yeast create esters
- High alcohol tolerance
- Huge variety in strains

Wit
Wyeast 1388
WLP570
WLP550
WLP400
Wyeast 3522
Strain Dependent

- **Lager**
  - Prefers cellar/cave temperatures
    - 50-55°F
  - Warmer = faster, but little flavor development
- **IPA**
  - Tropical, fruity
  - 60-70
- **Hefeweizen**
- **Belgian**
  - Warm fermentation encourages ester production
  - Massive variety with large strain variety
Over Attenuation

Hops Aren’t Just Hops

- Hops contain a variety of enzymes
  - Amyloglucosidase
  - Alpha-amylase
  - Beta-amylase
  - Limit-dextrinase
- So?
  - Dextrins!
  - Fermentables
  - Yeast in solution still?
- Bottling?
  - BOOM
Factors Influencing Over Attenuation

- **Time**
  - After dryhopping
  - Post packaging
- **Concentration**
  - Hops
  - Yeast
- **Temperature**
  - During fermentation/dryhopping
  - Conditioning/storage
- **Strain**
  - Hops
  - Yeast

New Dry Hopping Techniques
Biotransformation

Biochemical changes to hop compounds through contact with actively fermenting yeast

Not all hop compounds are created equal

- Not all hop compounds can be biotransformed
  - YES → some monoterpene alcohols
  - NO → major hop oil terpenoids

**Geraniol** Rose, Citrus

**Linalool** (S) Floral, Fresh
  - (R) Wood, Lavender, Coriander

\( \text{Geraniol} \)
\( \text{Linalool} \)
\( \text{Nerol} \)
Geraniol and Ales

Citronellol - sweet, rose, citrus, green

Nerol - green, fresh
Alpha-terpineol - lilac, peaches

Geraniol and Lagers

Citronellol - sweet, rose, citrus, green
Nerol - green, fresh

Linalool - fruity, tropical, fruit loops, candy

Alpha-terpineol - lilac, peaches

Geranyl acetate - floral, fruity, rose, ester!
Citronellyl acetate - ester! Floral, green, rose, citrus, woody, tropical fruit

Linalool and Ales

Alpha-terpineol - lilac, peaches
Nerol - green, fresh
Linalool and Lagers

Alpha-terpineol - lilac, peaches

Geraniol - rose, citrus

Nerol - green, fresh
In Summary

**Geraniol**
- **Citronellol**
  - Slightly more produced in ales
  - Slight decrease over time in lagers
- **Linalool**
  - Steady rates in both yeasts, then decline after 11 days
  - Less overall production in lagers
  - Nerol acts similarly
- **Some esters produced in lagers**
  - Geranyl acetate
  - Citronellyl acetate

**Linalool**
- Fewer products detected
- **D-terpineol**
  - Formed steadily in both yeasts
  - No sign of plateau or dropoff in 14 days
- **Geraniol/nerol**
  - Small quantities formed
  - Faster in lager than ale
Potential pathway for biotransformation by lager yeast - suggests possible additional “ester synthase” gene

1. Acetylation of geraniol
2. Reduction of geranyl acetate
3. Reduction of geraniol
4. Acetylation of citronellol

Presence of Nerol and Geraniol in ale yeast biotransformations suggest possible reversal of pathway
Note

- Brewing and beer fermentation present a rapidly changing environment for yeast
- Nutrients
- Ethanol
- Aerobic $\rightarrow$ anaerobic
- Heat
- Pressure
- One experience does not write the book
- Huge avenues for research in the future

Practical Application – Timing Matters

- Rapidly growing research field
- Experiment for yourselves!
- Hops before knock-out?
- Hops on day 1?
- Hops after fermentation?
- Hoppy beer landscape is constantly changing
- Check out his blog!
Thank Yous and Questions

- **Biotransformation of hop aroma terpenoids by ale and lager yeasts**
  - Andrew King, J. Richard Dickinson
- **Allagash**
  - Zach Bodah
  - Oregon State

**Kate Steblenko**

Lab Manager

Jack’s Abby Craft Lagers, Springdale Barrel Room

kates@jacksabby.com