DO TRY THIS AT HOME!

Emerging commercial brewery techniques

that you can apply to your homebrew

Kate Steblenko, 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

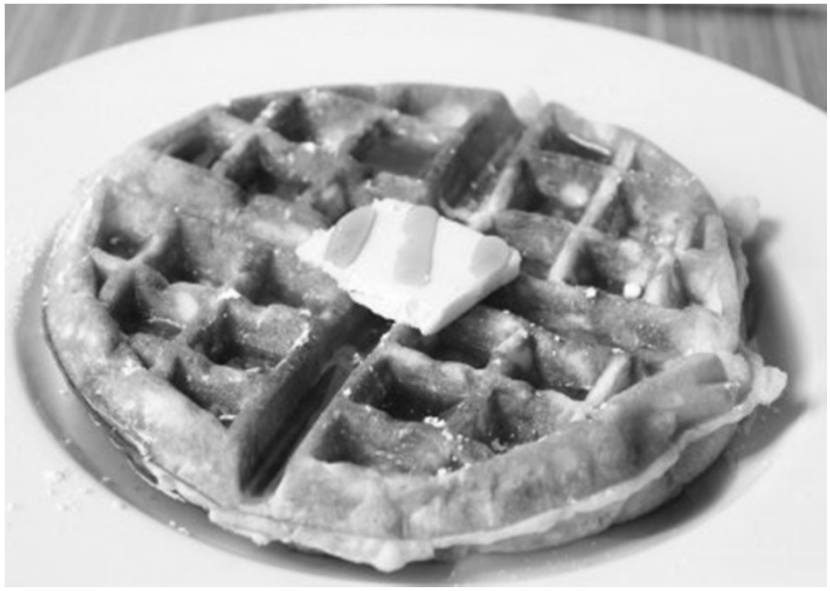
US-05 (Chico)
Burlington Ale (Conan?)
LalBrew New England Ale
S-04?

- **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

Belgian

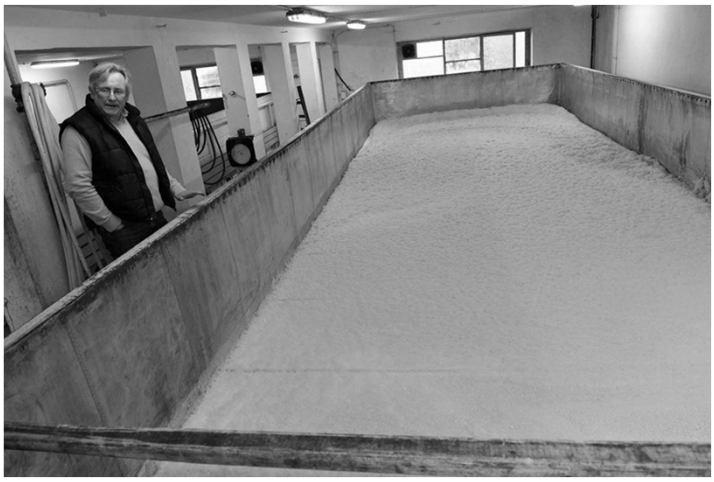
Wit
Wyeast 1388
WLP570
WLP550
WLP400
Wyeast 3522

- **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**



Strain Dependent

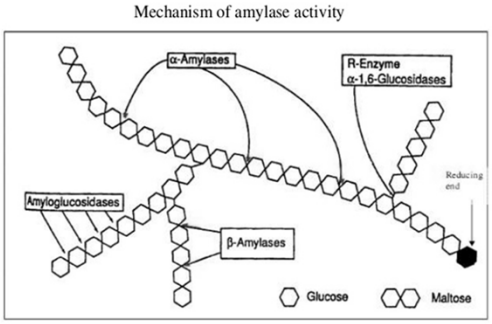
- **Lager**
  - Prefers cellar/cave temperatures
    - 50-55F
  - Warmer = faster, but little flavor development
- **IPA**
  - Tropical, fruity
  - 60-70
- **Hefeweizen**
- **Belgian**
  - Warm fermentation encourages ester production
  - Massive variety with large strain variety



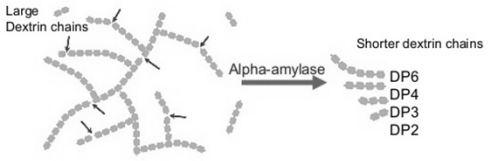
Over Attenuation

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



Manners et al, 1992



Factors Influencing Over Attenuation

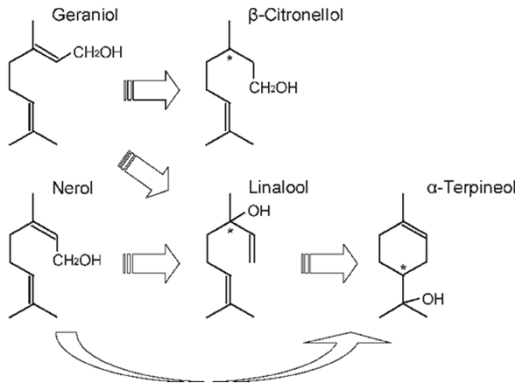
- **Time**
  - After dryhopping
  - Post packaging
- **Concentration**
  - Hops
  - Yeast
- **Temperature**
  - During fermentation/dryhopping
  - Conditioning/storage
- **Strain**
  - Hops
  - Yeast

New Dry Hopping Techniques

Biotransformation

- **Compounds**
- **Yeast**
- **Time**

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**

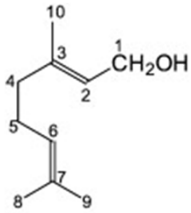
YES → some monoterpene alcohols

NO → major hop oil terpenoids

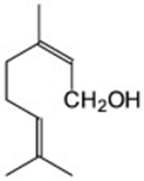
Geraniol **Rose, Citrus**

Linalool **(S) Floral, Fresh**

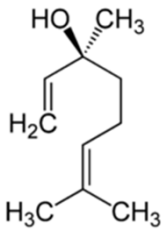
(R) Wood, Lavender, Coriander



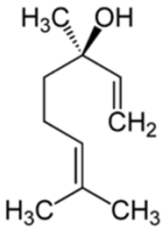
Geraniol



Nerol

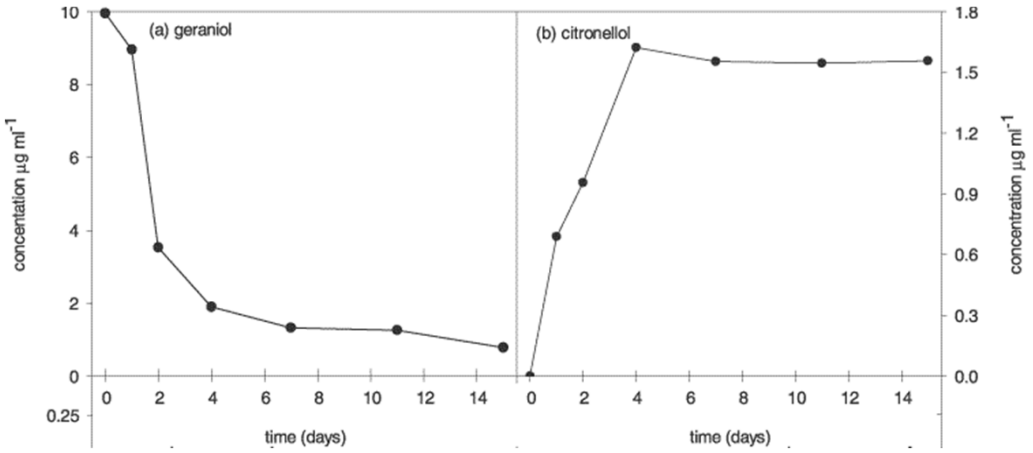


(S)(+)Linalool

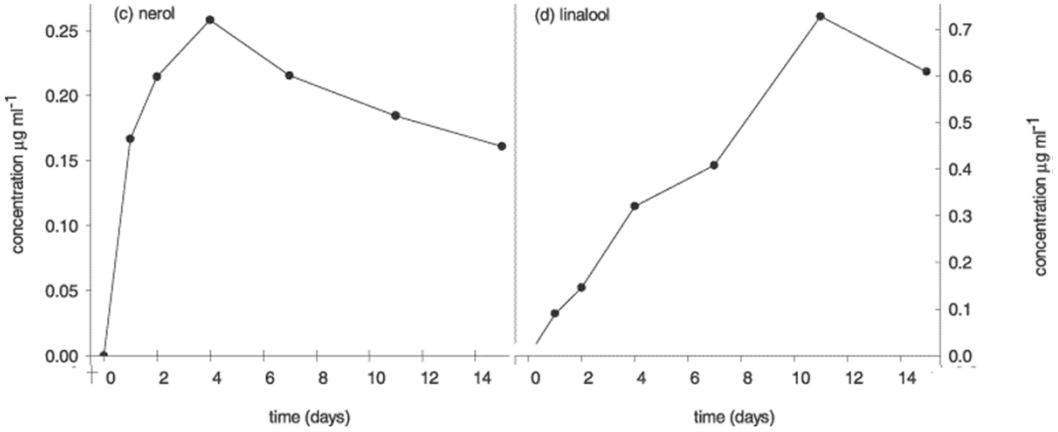


(R)(-)Linalool

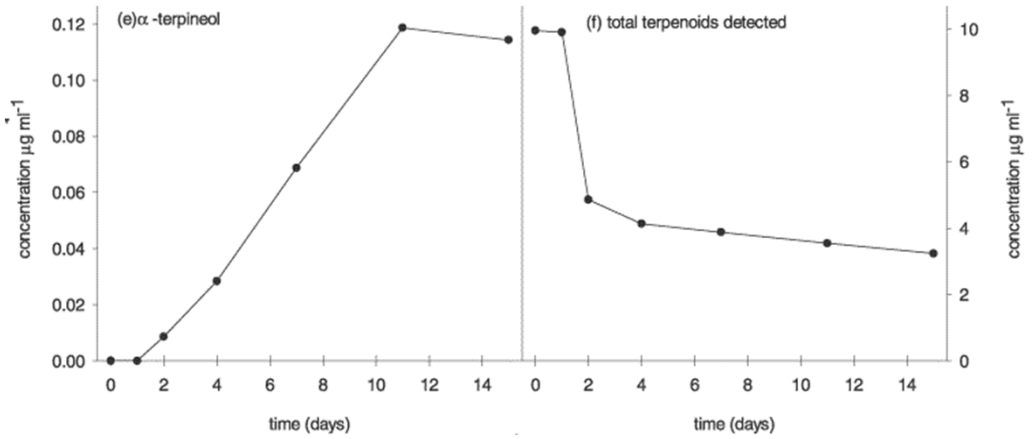
Geraniol and Ales



Citronellol - sweet, rose, citrus, green

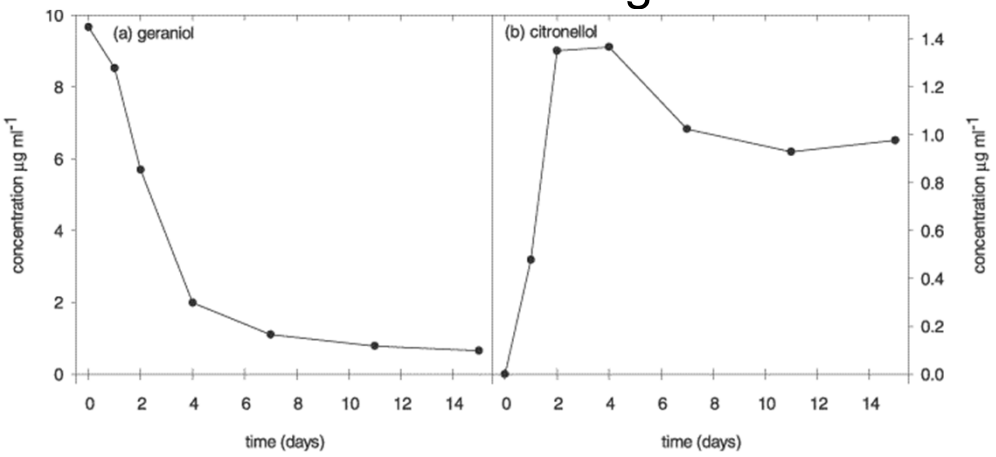


Nerol - green, fresh



Alpha-terpineol - lilac, peaches

Geraniol and Lagers



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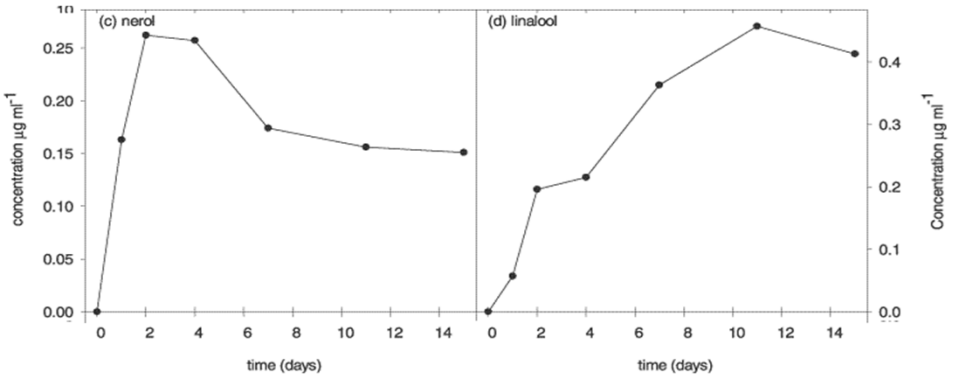
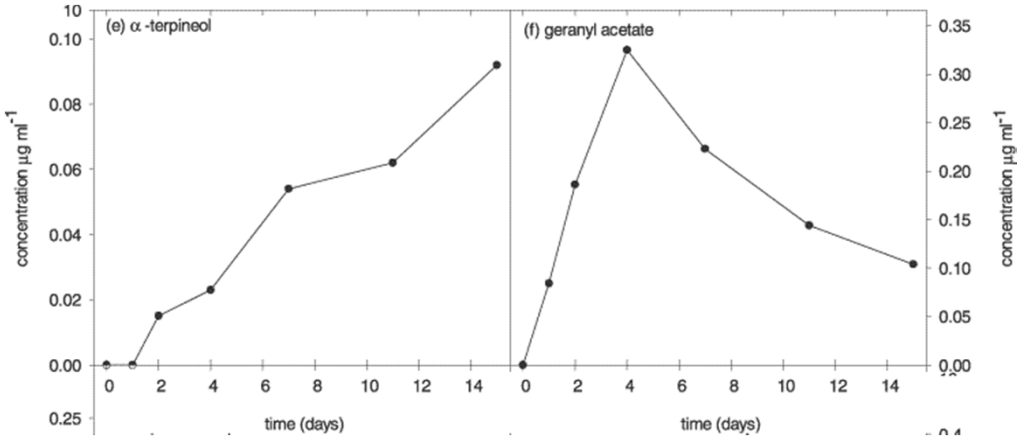


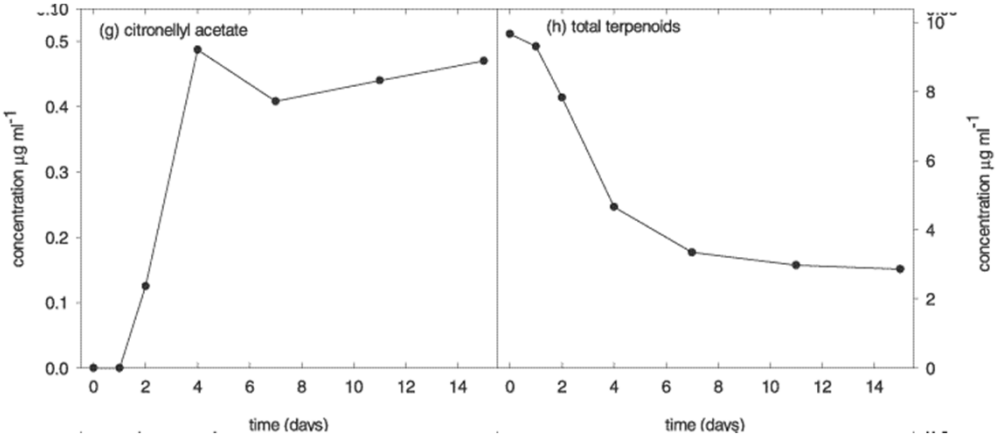
Nerol - green, fresh

Linalool - fruity, tropical, fruit loops, candy



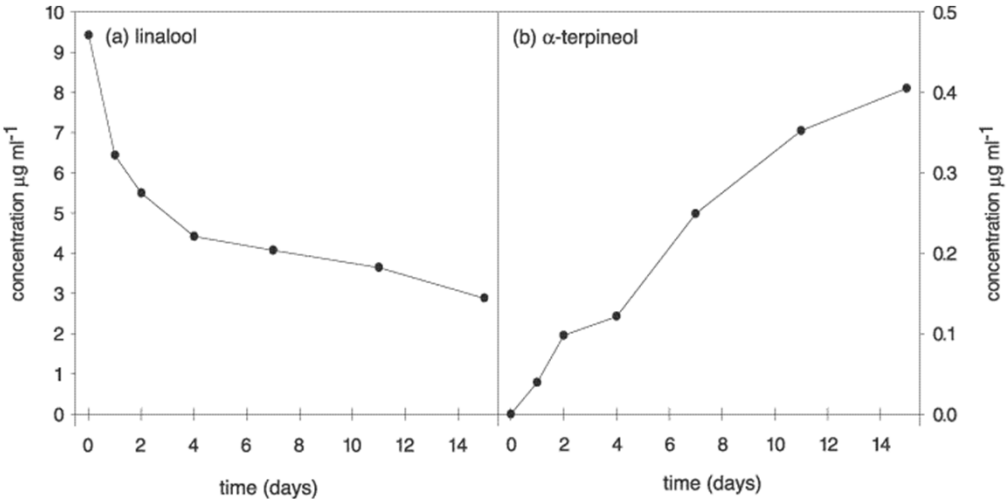
Alpha-terpineol - lilac, peaches

Geranyl acetate - floral, fruity, rose, ester!

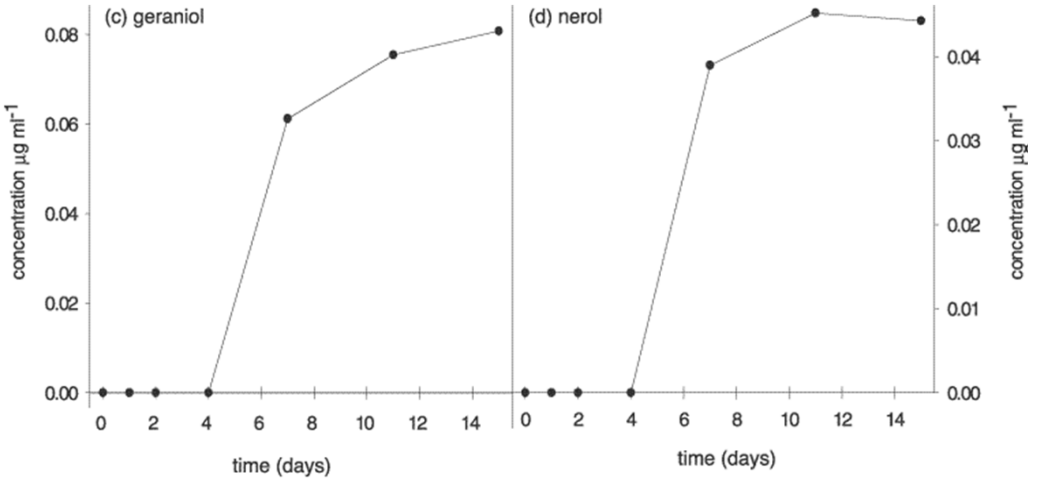


Citronellyl acetate - ester! Floral, green, rose, citrus, woody, tropical fruit

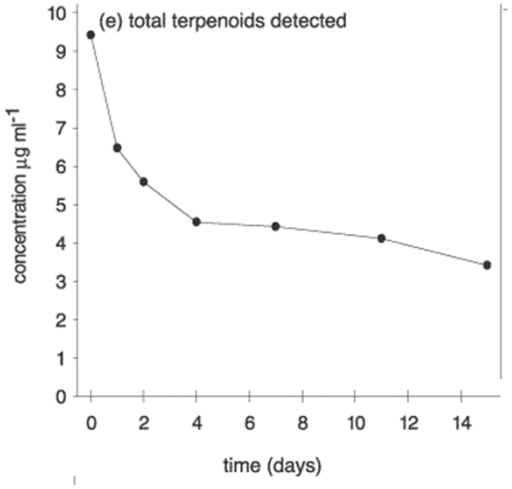
Linalool and Ales



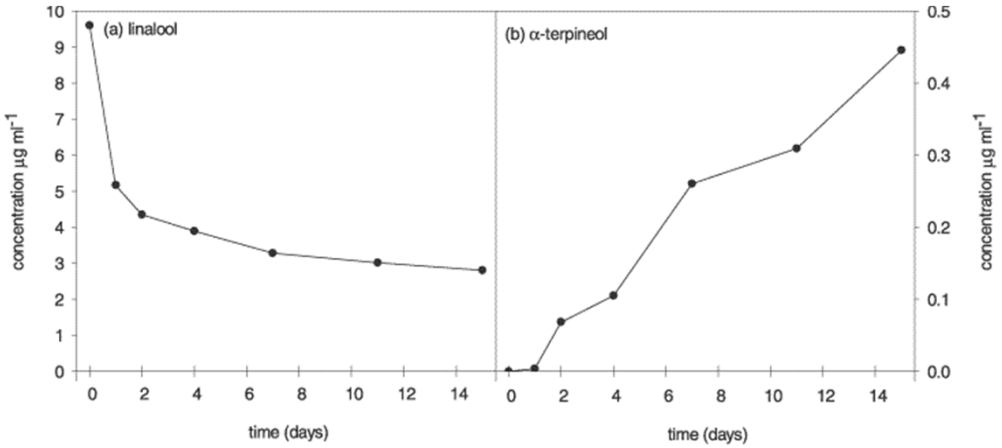
Alpha-terpineol - lilac, peaches



Nerol - green, fresh



Linalool and Lagers



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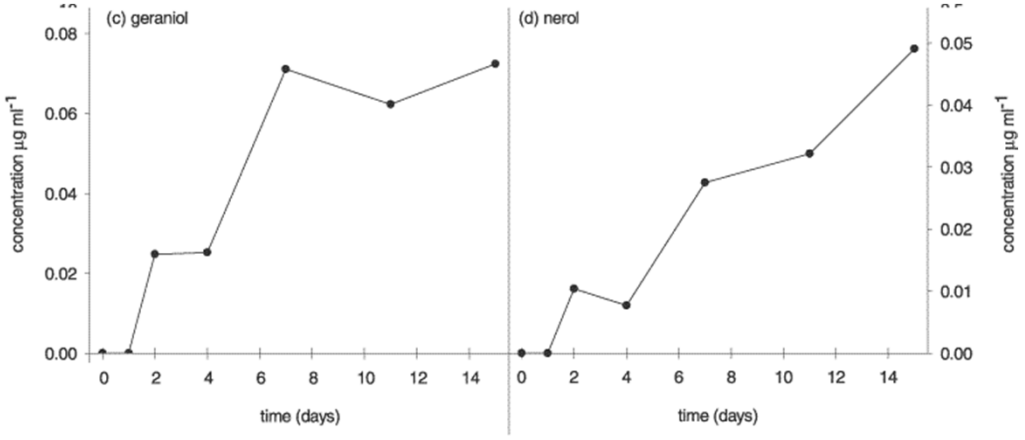
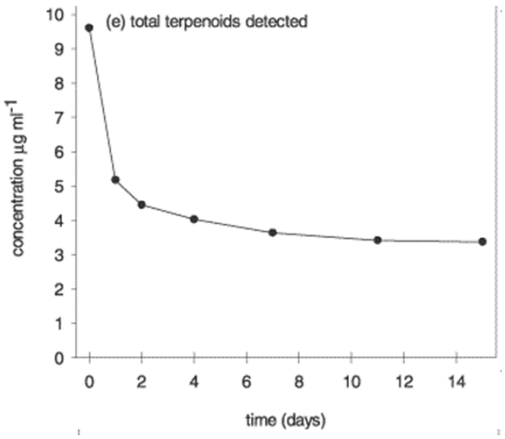


Geraniol - rose, citrus

Nerol - green, fresh



In Summary

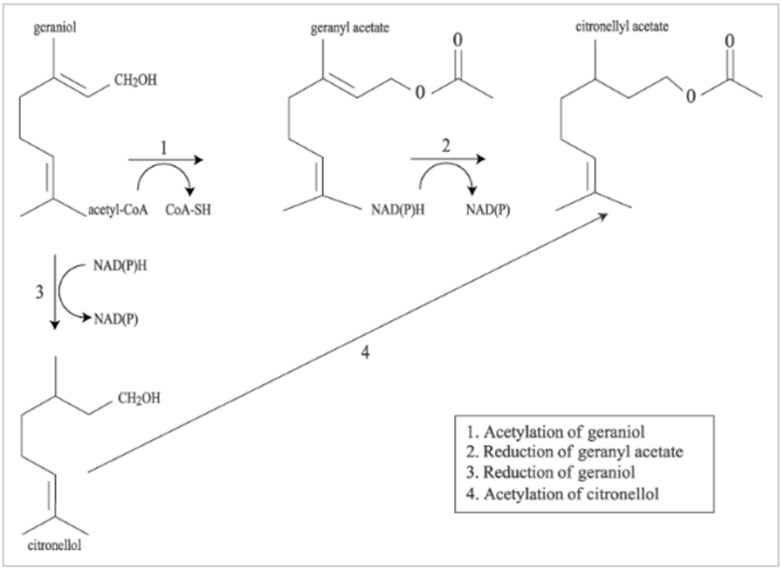
Geraniol

- **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

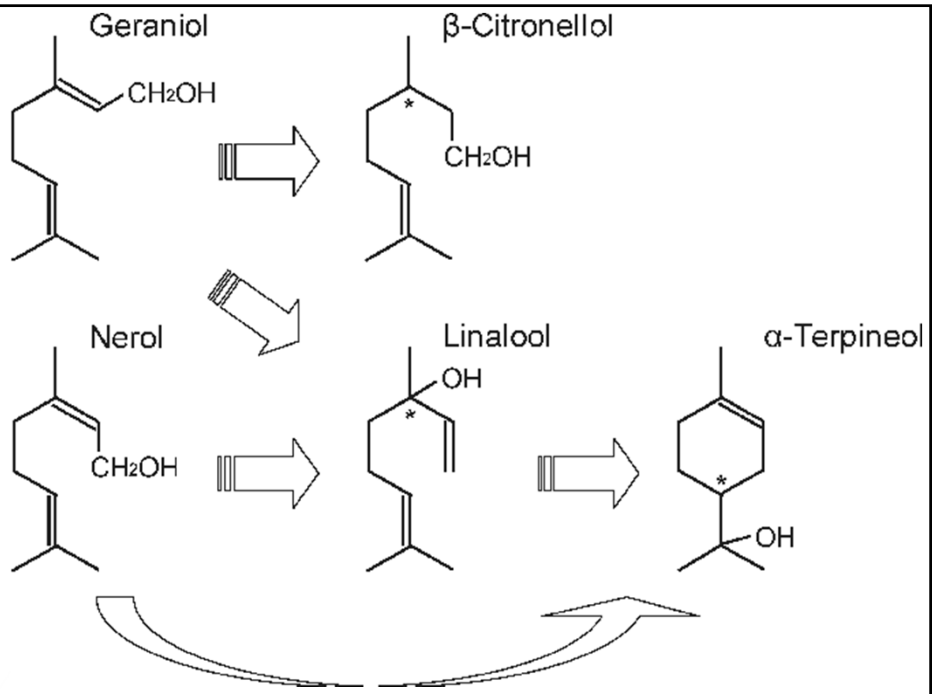
Linalool

- **Fewer products detected**
- **α-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



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 → 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**
- **(Future) Resource – Scott Janish, The New IPA: Scientific Guide to Hop Aroma Flavor**
- 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

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