

**Dialing in Haze**

# Methods for Producing Hazy Beer

California Craft Brewers Guild  
2022

Laura Burns

Omega Yeast



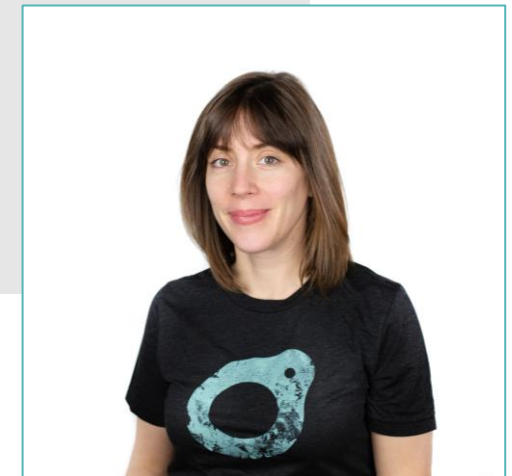
# Who are we?

Omega Yeast Labs  
Chicago, IL / St. Louis, MO

High quality, pitch-ready liquid yeast. Handful of microbiologists, homebrewers, professional brewers and craft beer fans who made it our express purpose to make brewing easier and better for everyone.

- Be Helpful
- Be Creative
- Be Fresh

[www.omegayeast.com](http://www.omegayeast.com)



Laura Burns  
Director of R&D

# What is Haze?

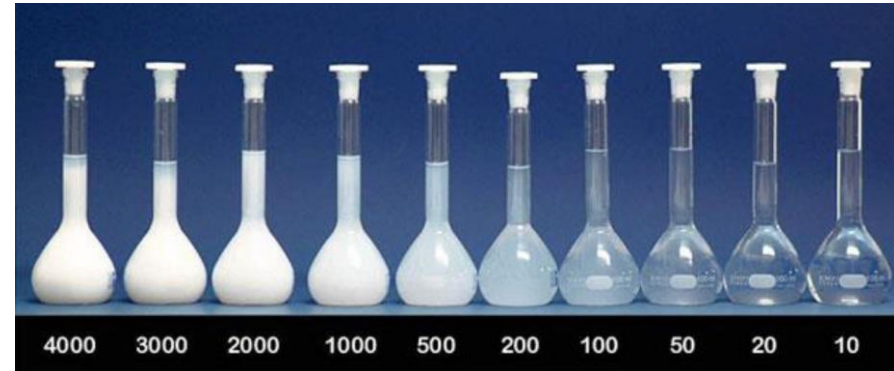
- Haze = Turbidity
- The cloudiness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye
- Analogous to fog or smoke in air



Maplewood Brewery & Distillery. Chicago, IL

# Haze = Turbidity

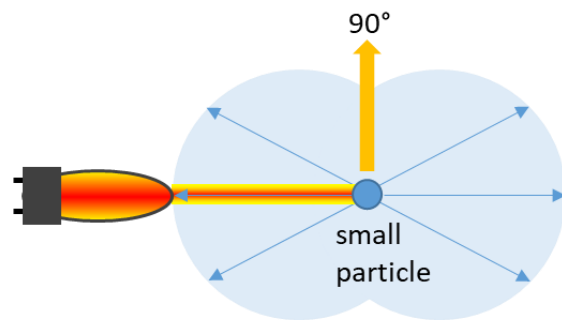
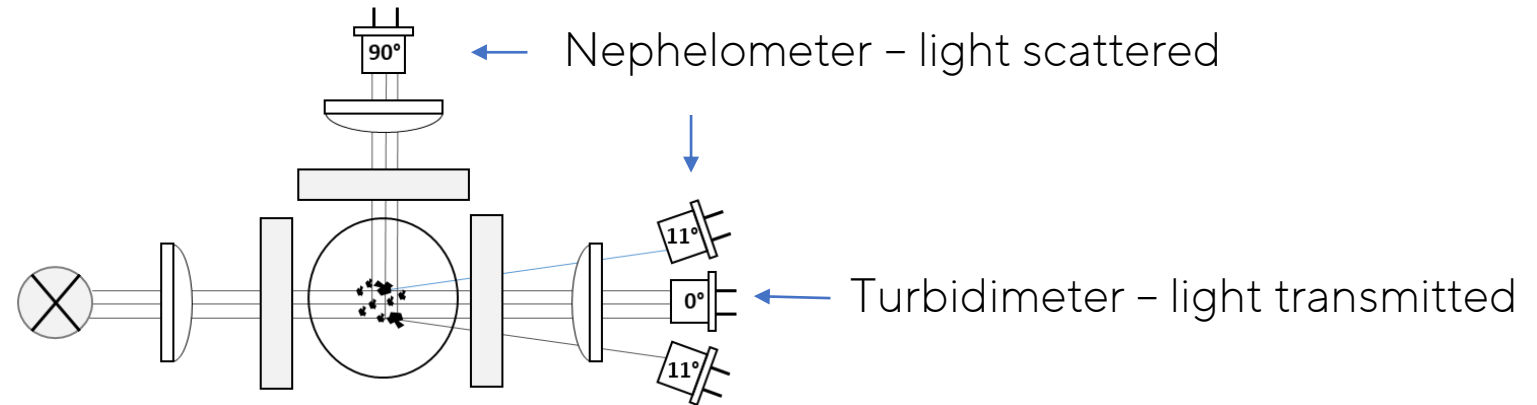
**Turbidity** is the cloudiness or **haziness** of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to fog in air.



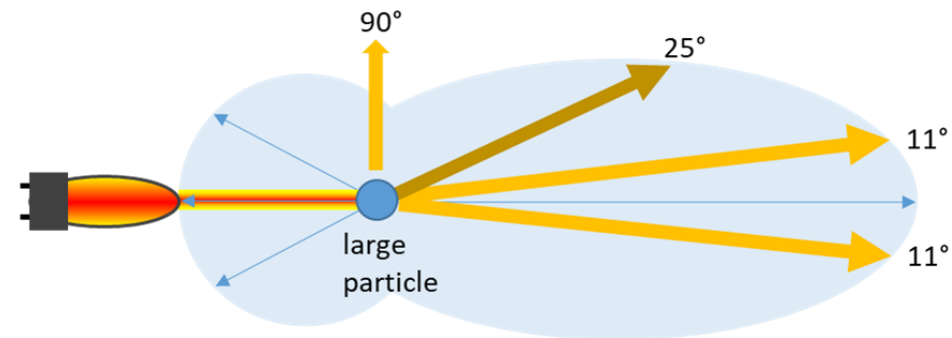
Sample	Turbidity Measurement
Drinking water	0.05-1.5 NTU
Lager	5-20 NTU
Porter	20-200 NTU
Hazy IPA	200-1000 NTU
Orange juice	300-900 NTU
Milk	>4000 NTU



# Particles **refract** light at different **angles** depending on their size



0.01-1  $\mu\text{m}$   
Proteins, polyphenols, polysaccharides, minerals



<1  $\mu\text{m}$   
Yeast, bacteria, larger protein-polyphenol complexes

# Measuring Turbidity - turbidimeters/nephelometers

## IN THE LAB

1. Anton Paar HazeQC ME
  - measures 90°, 25°, and 0°



2. Hach Turbidimeter
  - measures 90° and/or 0°



3. Optek Haze Control DT9011
  - measures 90°, 11° and 0°



## IN THE BREWERY

4. Haffmans OptHaze-i
  - measures 90°, 25°, and 0°



5. Separators
  - measures 90° and/or 0°



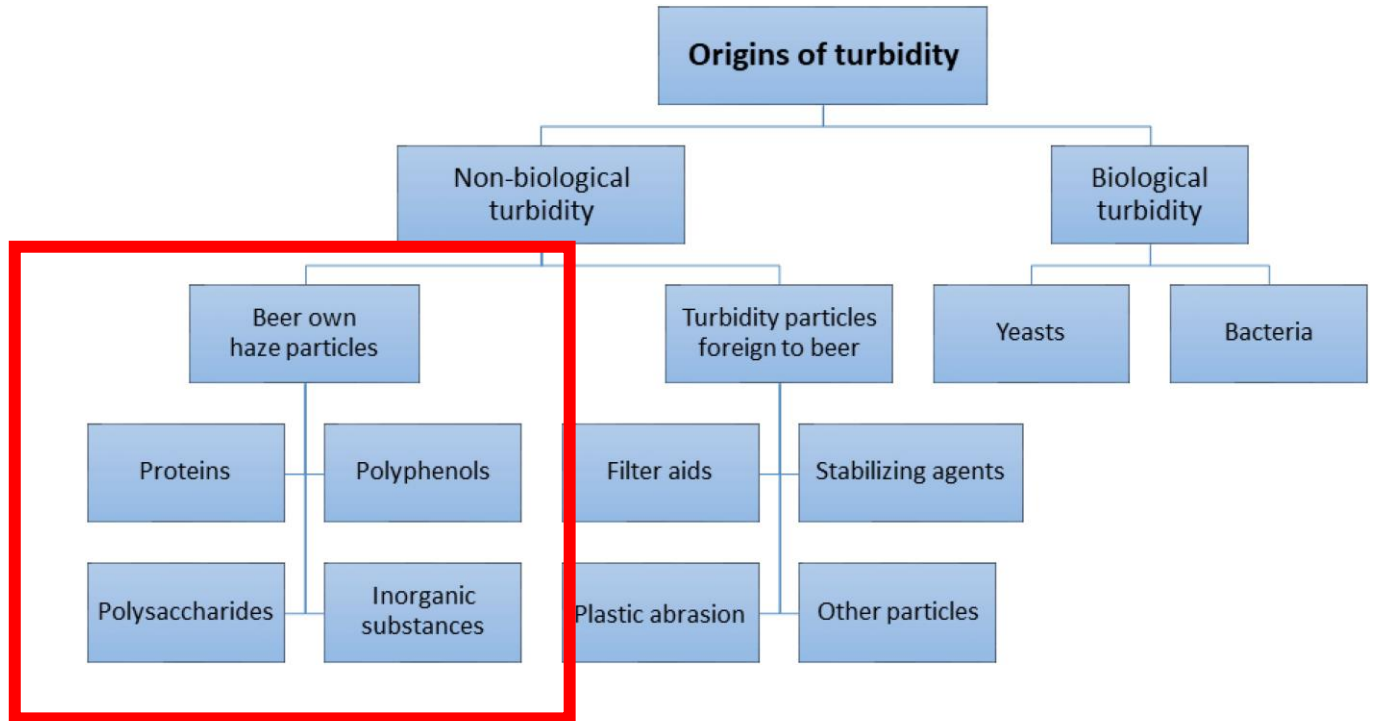
# What kind of haze are we talking about?

Dry hop-dependent

- Colloidal haze
- Likely polyphenol-protein derived

Yeast-dependent

Not yeast in suspension!



Kahle EM, Sarnkow M and Jacob F. *JASBC* 2020.

# HAZE

## Origins of Haze

### PROTEINS

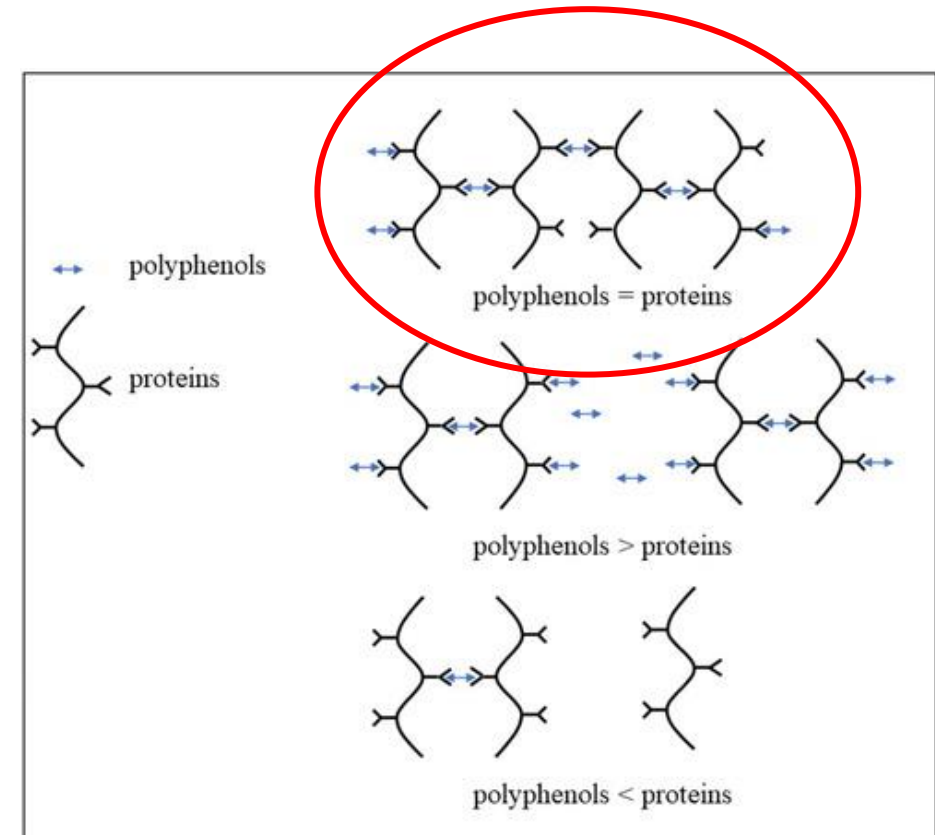
Major malt-derived proteins

- Proline-rich (different from foam stabilizing proteins)
- Barley Hordein (20% proline)
- Wheat Gliadins (15% proline)
- Haze generating smaller <40kDa peptide/proteins

### POLYPHENOLS

Proanthocyanidins

- monomers, dimers, trimers and higher polymers of catechin, epicatechin and gallocatechin



Kahle EM, Sarnkow M and Jacob F. *JASBC* 2020.



# Origins of Haze

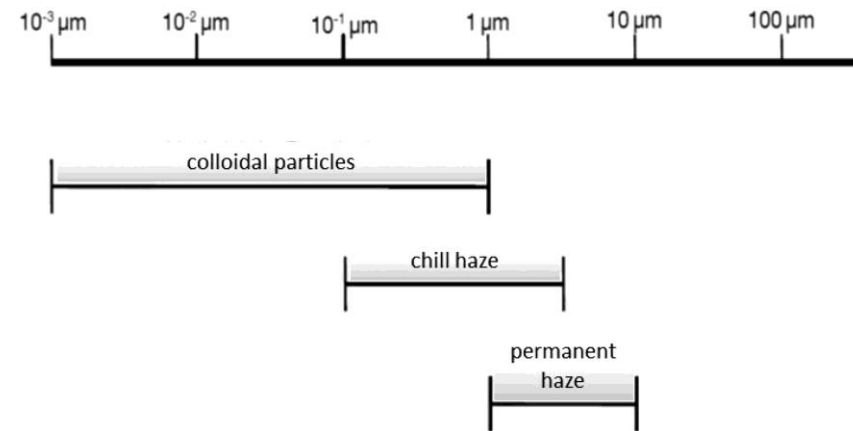
## protein-polyphenol interactions

### Chill Haze:

- Non-covalent interactions
  - hydrogen and hydrophobic bonding
- Reversible
  - Occurs at 0°C but goes away at 20°C

### Permanent Haze:

- Covalent bonding
- Often occurring with increasing age, repeated cooling and warming, pasteurization, oxidation



# Origins of Haze

## POLYSACCHARIDES

1. Malt-derived glucans
2. Fruit-derived pectin
3. Yeast-derived glycogen, mannans, glucans



# Why do we want haze?

Hopsteiner studies:

*The “hidden secret” of NEIPAs*

*NEIPAs: “the hop aroma champion of beers”*

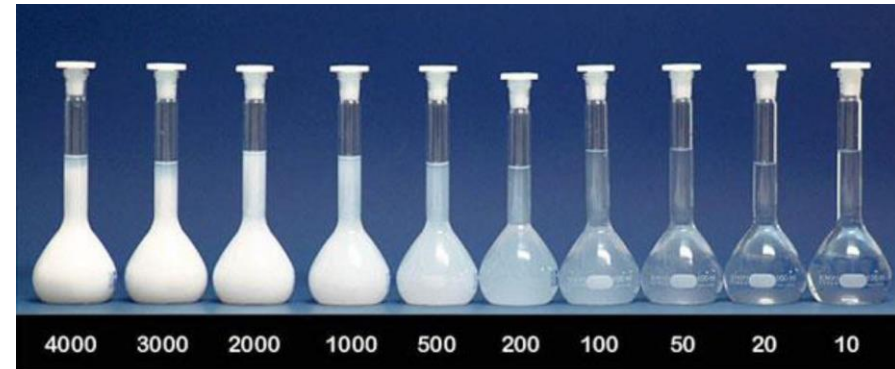
Haze is a carrier for hop flavor!

As haze increases, it acts as an emulsifier for nonpolar hop compounds.



# What kind of haze are we talking about?

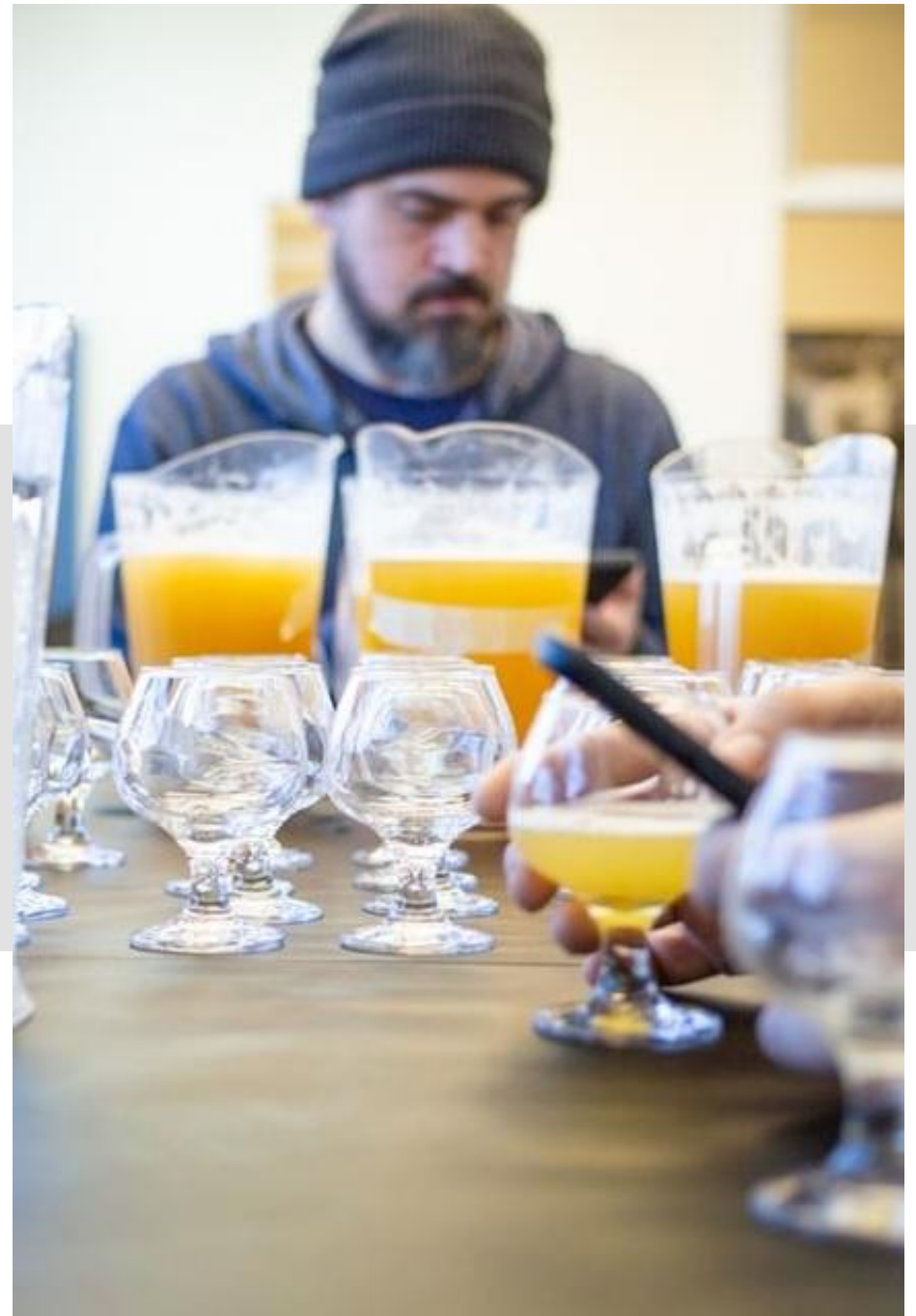
NEIPA levels



Sample	Turbidity Measurement
Drinking water	0.05-1.5 NTU
Lager	5-20 NTU
Porter	20-200 NTU
Hazy IPA	200-1000 NTU
Orange juice	300-900 NTU
Milk	>4000 NTU

# Yeast-Dependent Haze

1. Yeast Strain Specific:
  - “Haze Positive”
  - “Haze Neutral”
2. How does dry hopping play in?
  - Timing
  - Hop products/dose rates





# Development of an Assay to Assess Yeast-Dependent Haze

Wort: All barley malt (2-row) for target 15°P

Strains : Haze Positive OYL-011, Haze Neutral OYL-004

Pitch Rate: 10 million/ml

Temperature: 70°F

Fermentation End Point: 14 days

Dry Hop Amount: 2 lb/bbl (8g/L)

Dry Hop Addition:

- Control (no dry hop)
- Knockout (in fermentor pre-pitch)
- Day 1
- Day 2
- Day 3
- Day 4
- Day 7
- DDH (½ Day 1, ½ Day 7)



# Dry Hop Timing and Yeast Choice - Dramatically Impacts Degree of Haze

Haze Positive  
OYL-011  
British V, London III



→  
Dry Hop Timing

Haze Neutral  
OYL-004  
West Coast Ale I, Chico

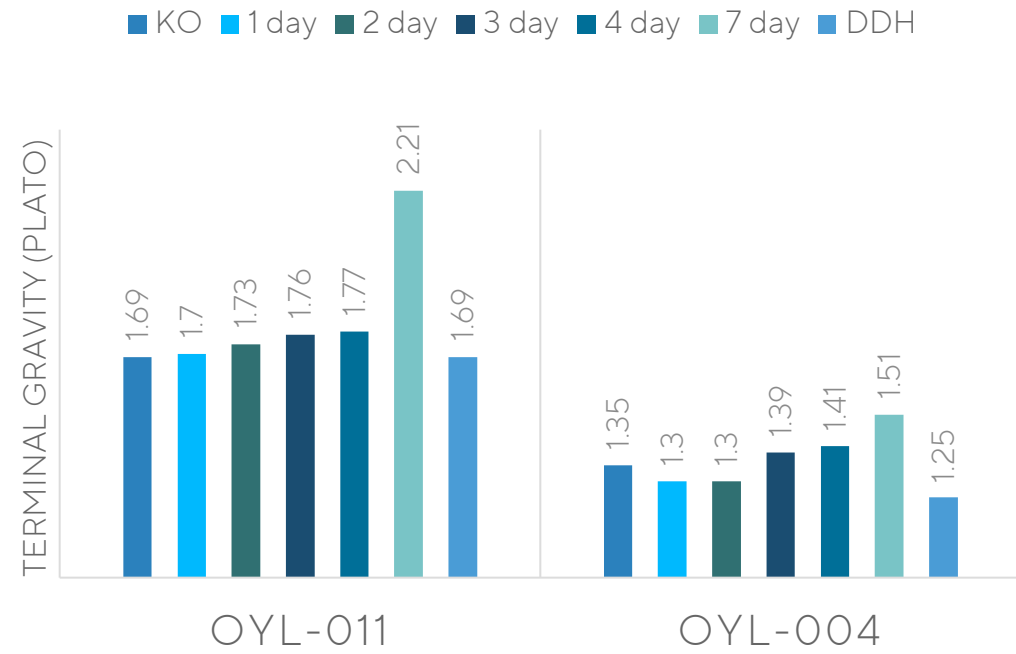
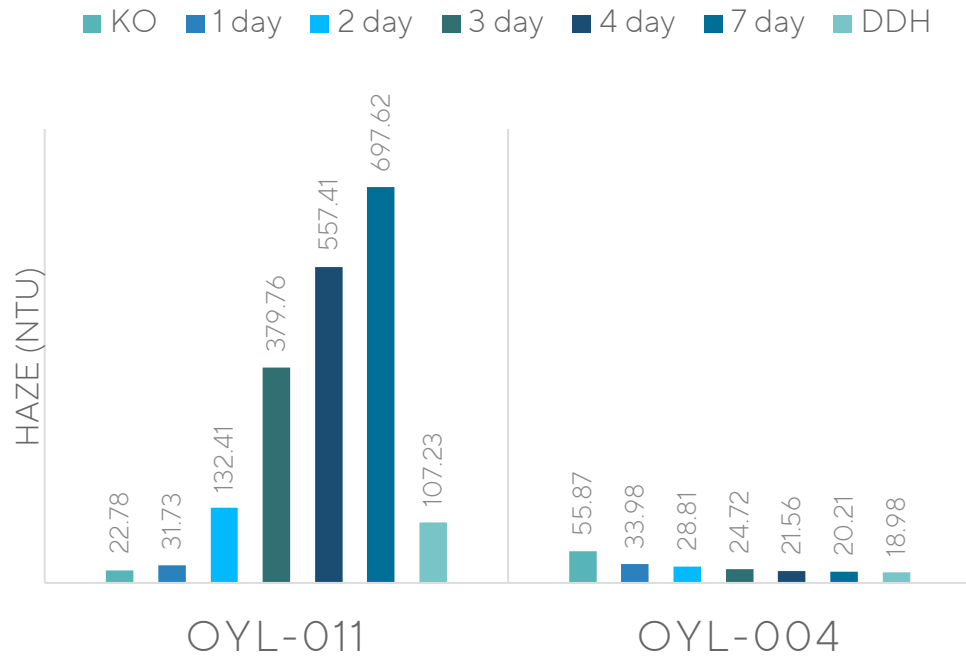


→  
Dry Hop Timing

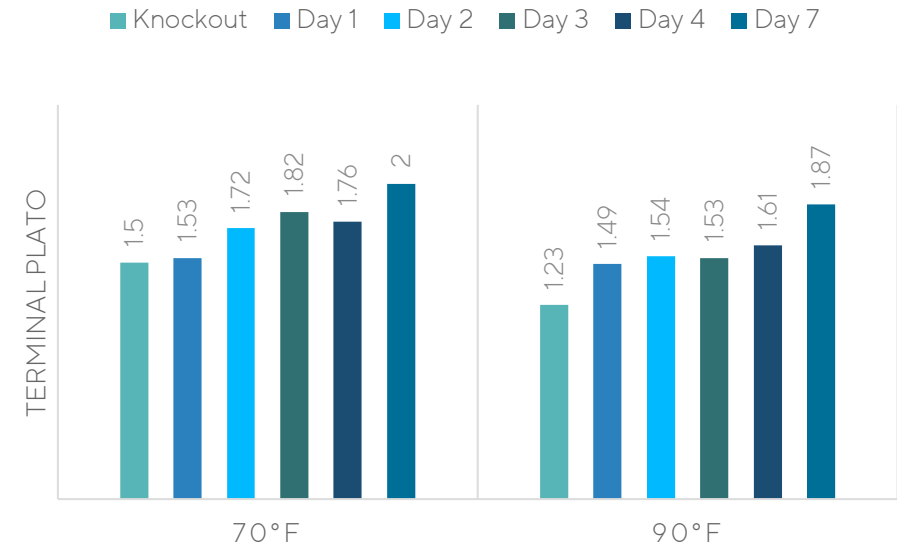
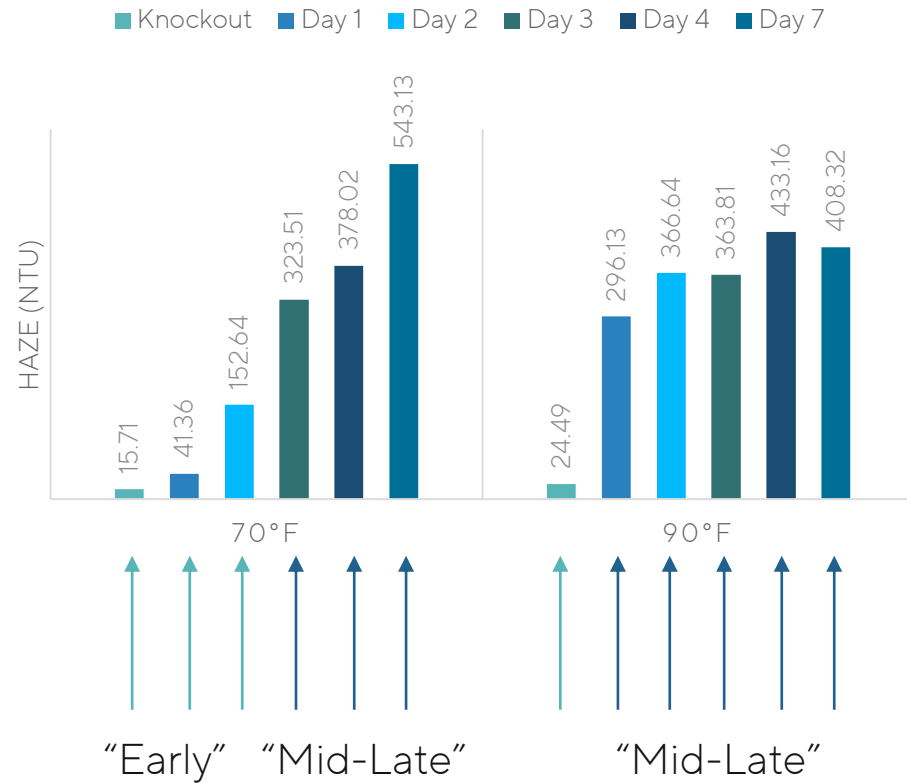
Pictures at 14 days from left to right:

- Control (no dry hop)
- Day 0 "Knockout"
- Day 1
- Day 2
- Day 3
- Day 4
- Day 7
- DDH (Day 1 and 7)

# Dry Hop Timing and Yeast Choice - Haze Independent of Terminal Plato



# Fermenting Voss Kveik at Elevated Temperatures Speeds up Fermentation and Dry Hop-Dependent Haze



Finishing Plato not correlated with haze

# Grouping strains:

## Haze Positive or Haze Neutral

### Haze Positive

#### Hazy IPA strains

- OYL-011 British V (Juice/London III/1318)
- OYL-061 Voss Kveik
- OYL-006 British I

### Haze Neutral

#### American IPA strains

- OYL-004 West Coast I (Chico)
- OYL-052 DIP A Ale (Conan)
- OYL-200 Tropical IPA

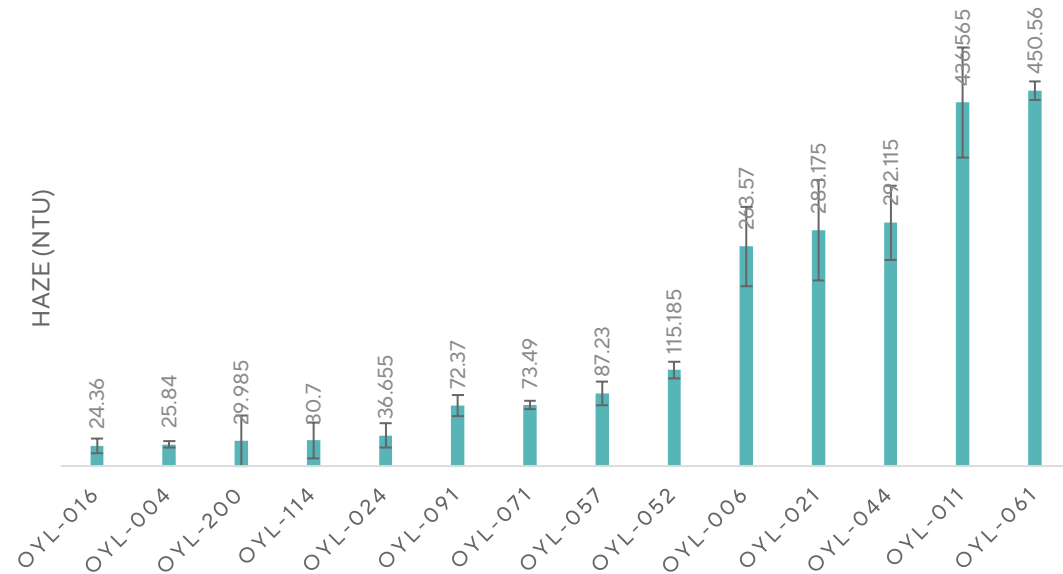
#### German/Belgian Strains

- OYL-044 Kolsch II
- OYL-030 Belgian Wit
- OYL-021 German Hefeweizen
- OYL-024 Belgian Ale

#### Haze Neutral (or Negative?)

- OYL-057 Hothead Kveik
- OYL-071 Lutra Kveik
- OYL-016 British Ale VIII (Fullers)
- OYL-091 Hornindal Kveik
- OYL-114 Bayern Lager

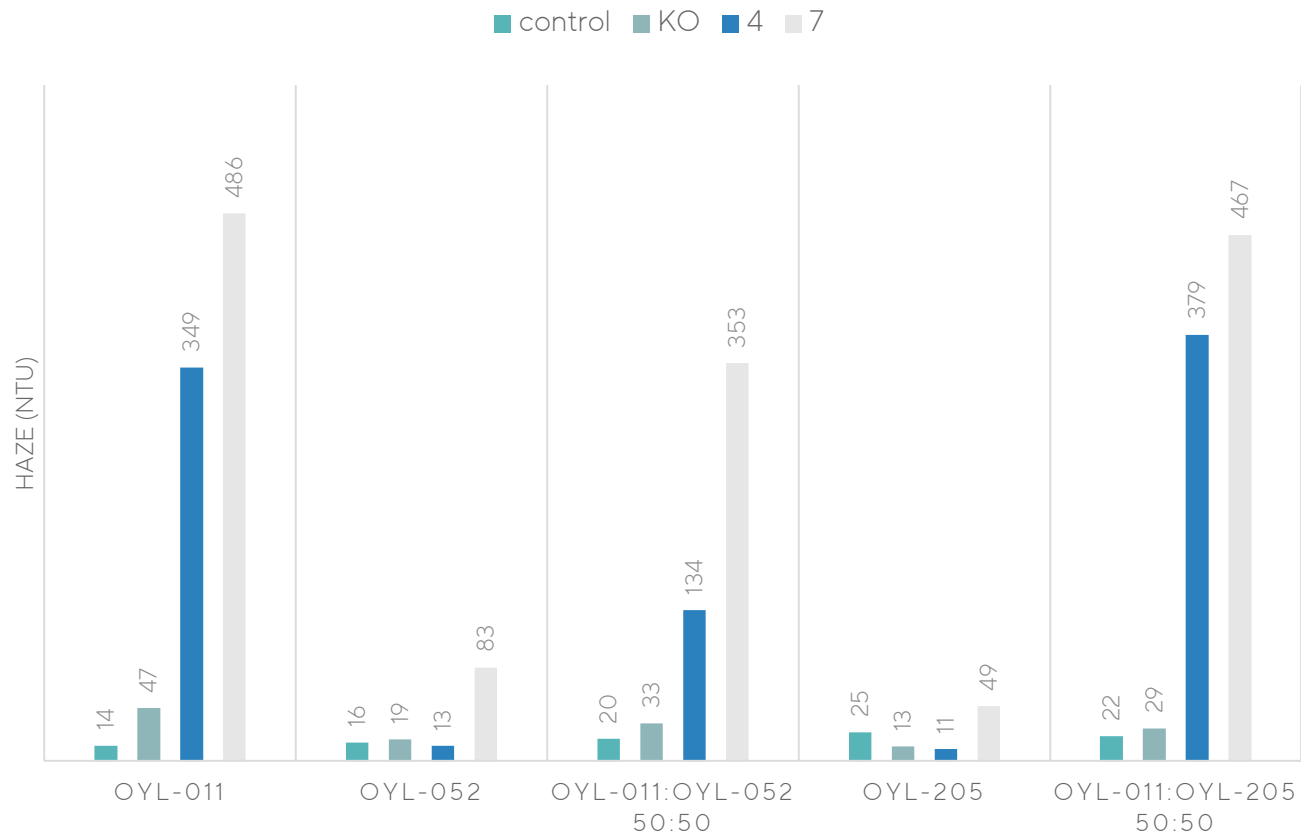
Haze (NTU) with 2 lb/bbl dry hop addition at day 7



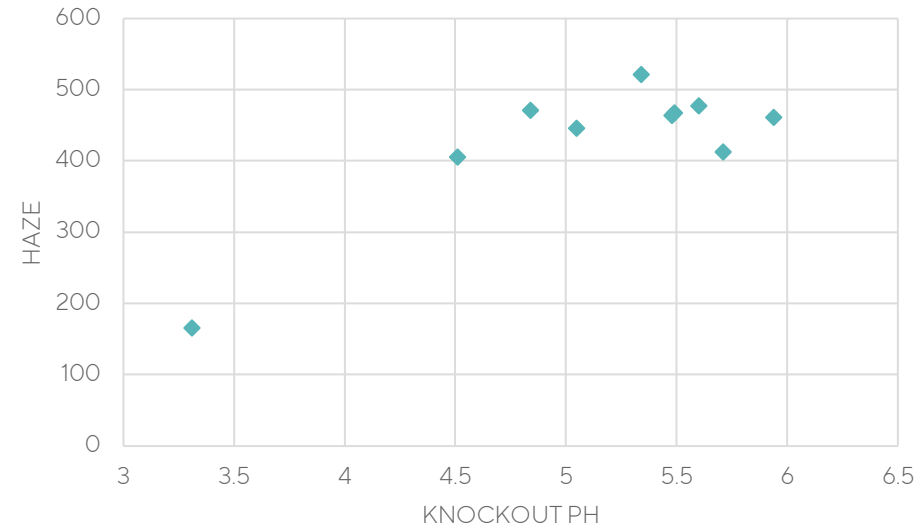
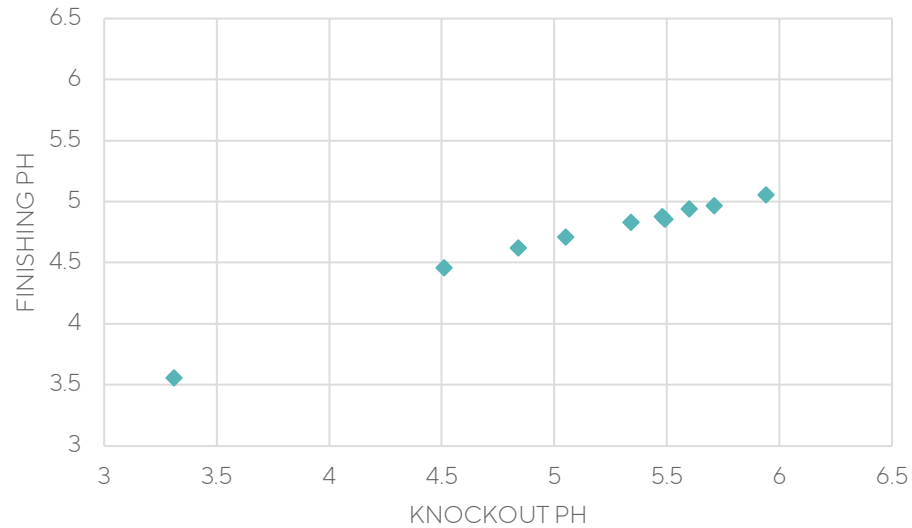


# Yeast Blends:

## Maintain Haze of Haze Positive Strain



# Haze occurs across a range of knockout pHs



Knockout pH was adjusted with lactic acid and NaOH between pH 4.5 and 6 and fermentations were dry hopped on day 7

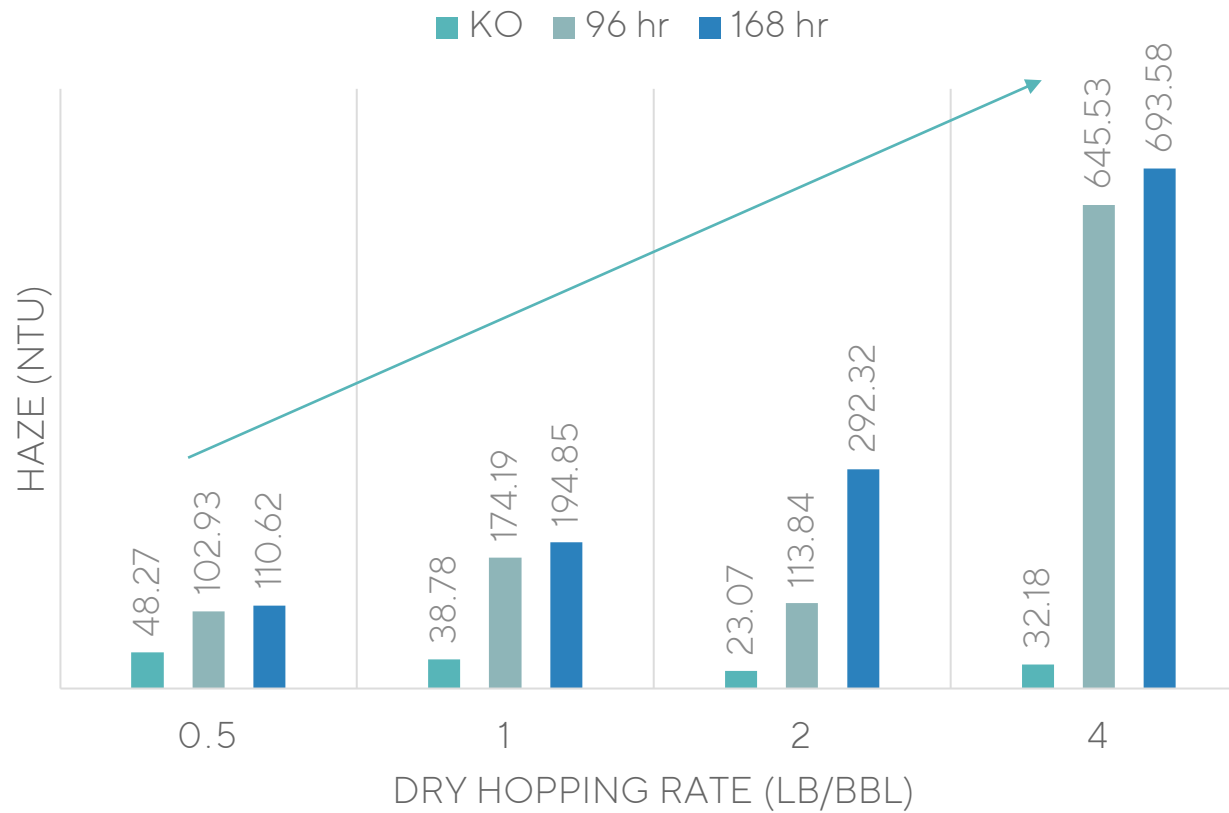
# Remaining Experiments

Further characterization of this dry hop-dependent haze with our OYL-011 "Haze Positive" Strain

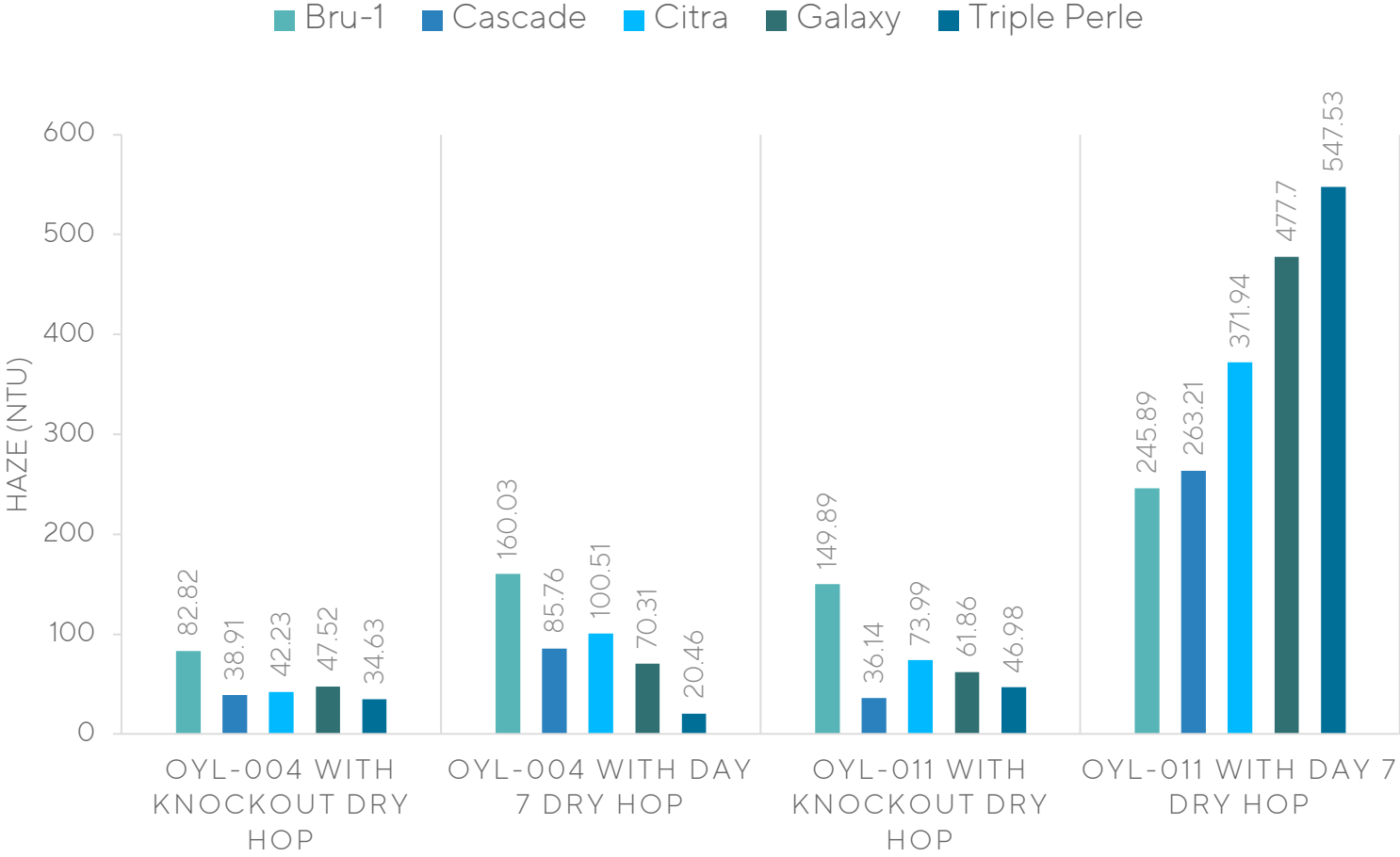
- Hopping Rate
- Hop Variety
- Hop Products
- Hop Polyphenols
- Early Dry Hopping vs. Late Dry Hopping?



# Haze increases with dry hopping rate



# Haze levels depend on hop variety

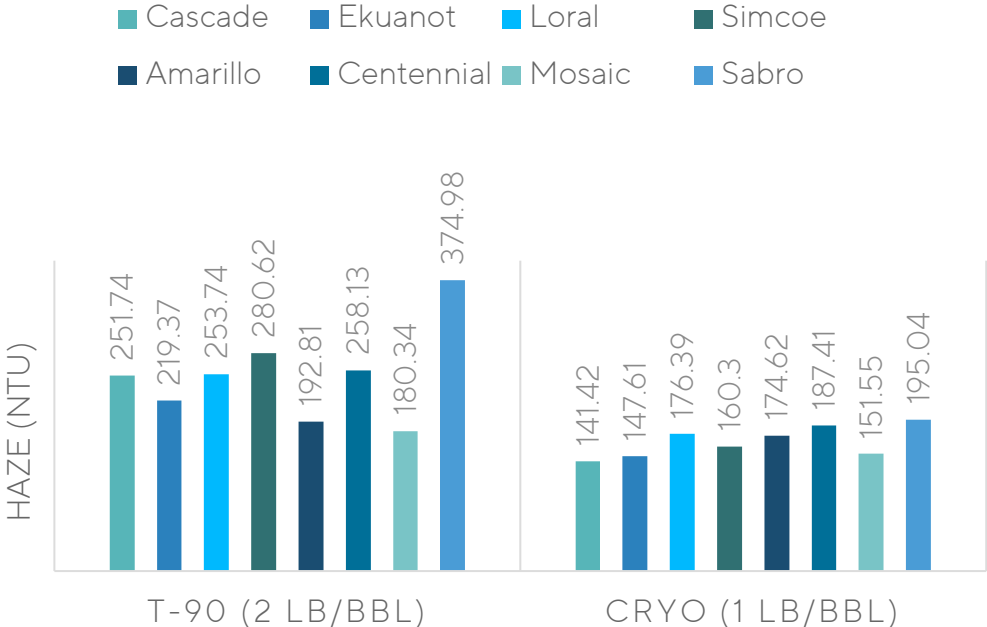
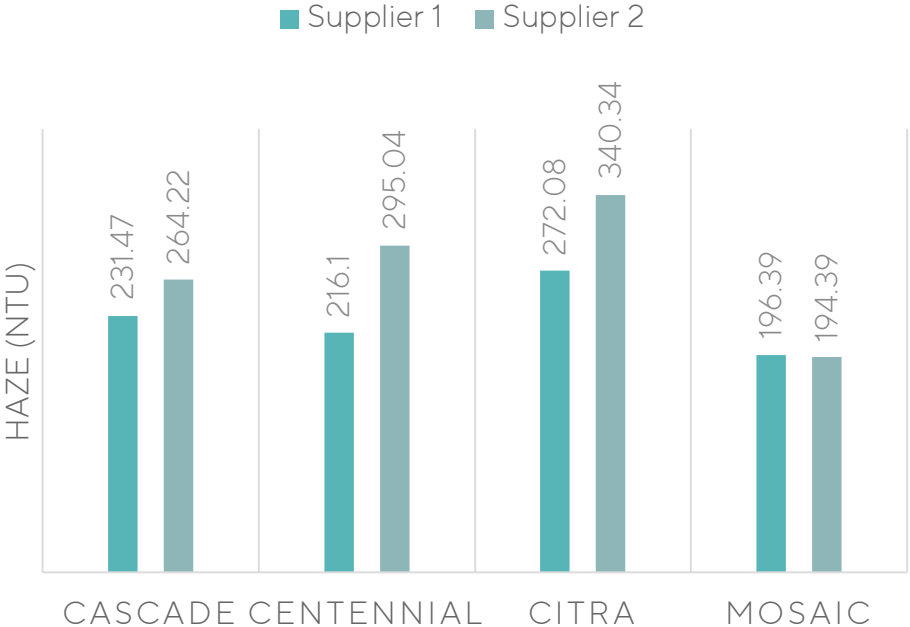




# Haze levels depend on hop variety and hop products

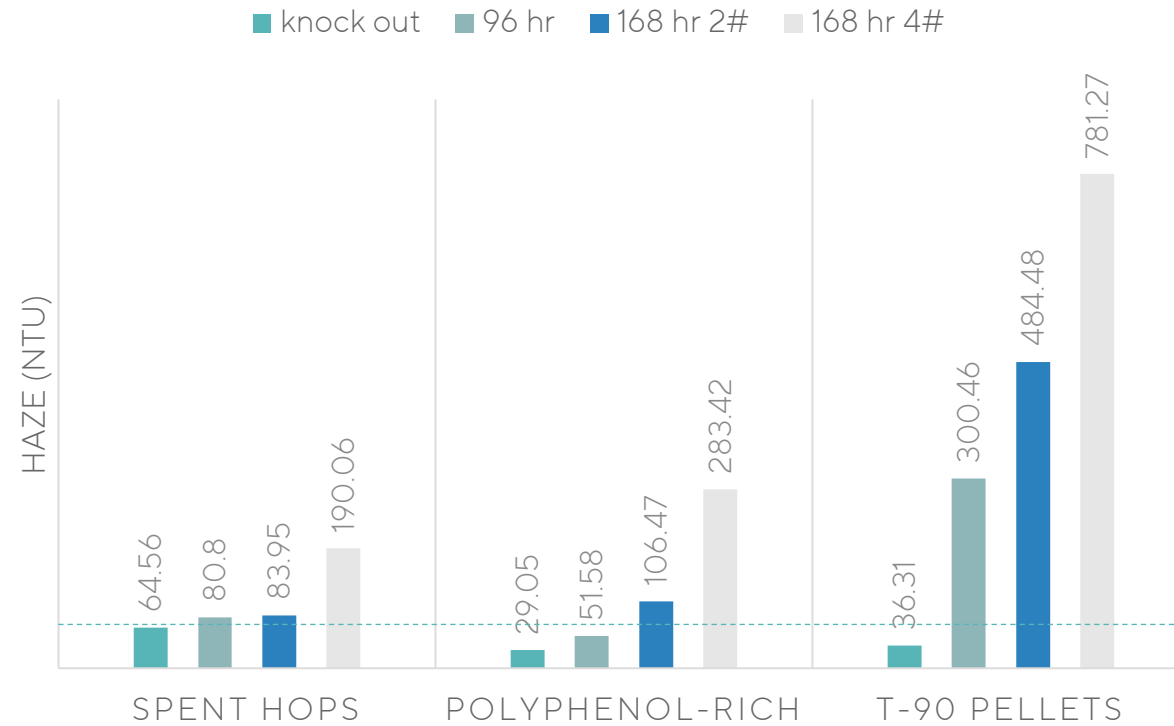
Overall trends show variety specific impacts on haze

Cryo and T-90 pellets show different haze potential



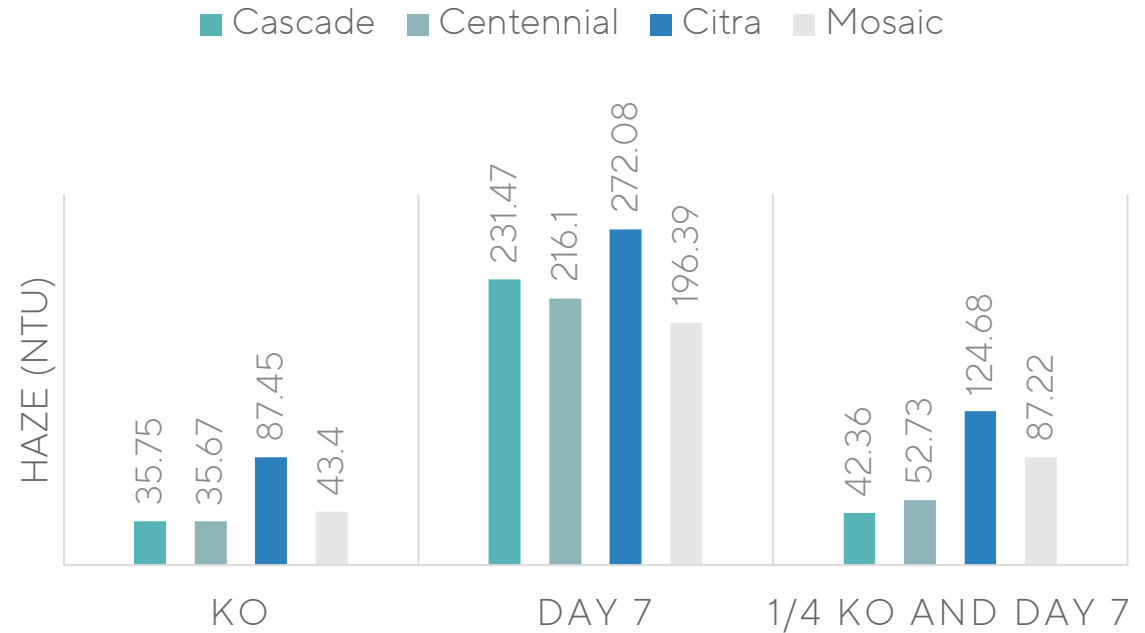
# Testing Different Hop Products

Maybe not just polyphenols?



# Double Dry Hop Experiments

Early Hop Additions - Haze Neutral or Haze Negative?



# Pilot Brew

Can we make a bright NEIPA with an addition of a 0.5 lb/bbl of knockout hops?

## Recipe Details

Wort: 100% 2-row, 16.7°P

Strain : Haze Positive OYL-011

Pitch Rate: 10 million/ml

Temperature: 70°F

Fermentation End Point: 14 days

Whirlpool Hops: 1 lb/bbl Citra, Wai-iti, and Mandarin Bavaria

Dry Hop:

Hazy Control: Day 4 alone

Experimental: Knockout + Day 4

Cold crashed at Day 14 for one week and transferred to keg

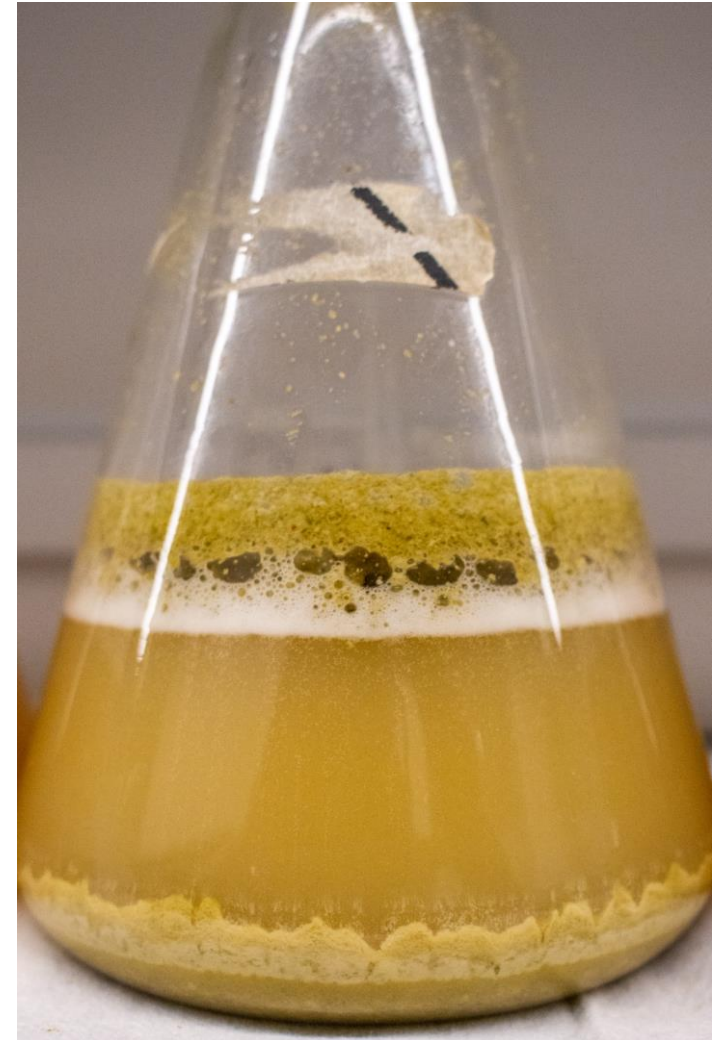
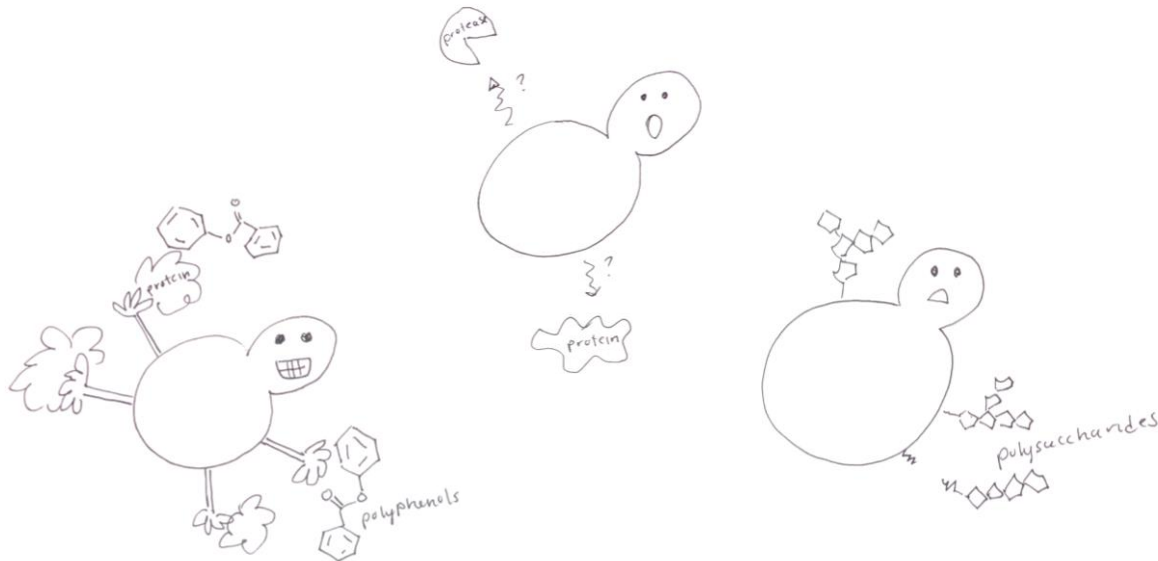


	Hazy Control Pictured Left	Experimental Pictured Right
Knockout	-	0.5 lb/bbl
Day 4	2 lb/bbl	2 lb/bbl
Haze	487 NTUs	34 NTUs
ABV	7.60 %	7.61%
AE	2.93	2.86
pH	4.66	4.7

# What makes a strain “Haze Positive” or “Haze Negative”?

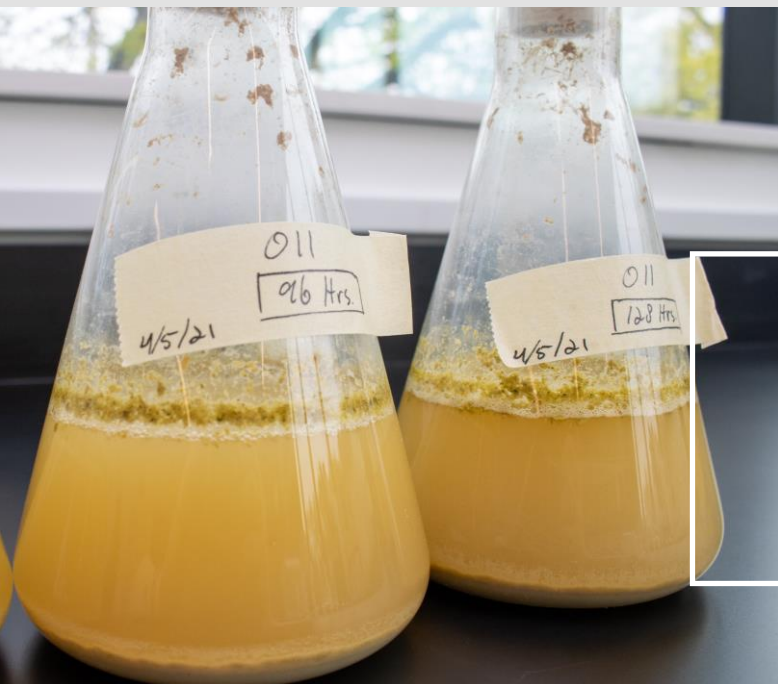
## Current ideas:

- Adsorption of polyphenols/proteins by yeast cell wall
- Yeast secreted protein (or secreted proteases)
- Cell wall polysaccharides (Mannan,  $\beta$ -glucan)
- Impact of yeast on pH and non-covalent interactions





# Wrapping up



HAZE

Mid-late dry hopping promotes haze in combination with select yeast strains

- London III/British V (OYL-O11), Voss (OYL-061) are go to “Haze Positive” strains
- Chico (OYL-004), Conan (OYL-052), Tropical IPA (OYL-200) will require more effort to achieve stable haze

Early dry hopping (first 48 hours) as a potential method for removing haze?

- When you are looking for Crystal Clear IPAs or Lagers, potentially small hop charges in early fermentations will help... experiments in progress!

Many reasons for dry hopping in mid-late fermentation

1. Biotransformation potential
2. Mitigating Hop Creep
3. Cropping yeast for repitch/harvest before hop additions
4. **TO PROMOTE HAZE!**

# Thank you!!

Acknowledgments:

Lance Shaner, PhD  
Keith Lacy  
Chris Bernardo



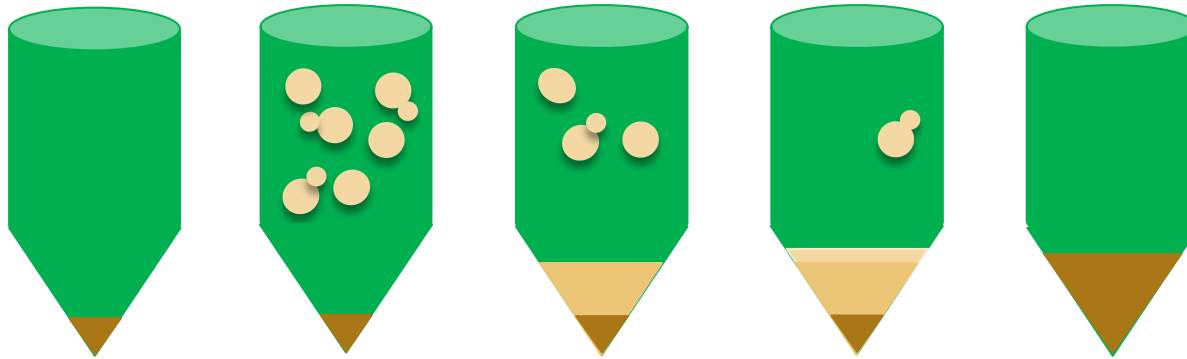
The Omega Yeast Crew

Contact me:

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[laura@omegayeast.com](mailto:laura@omegayeast.com)

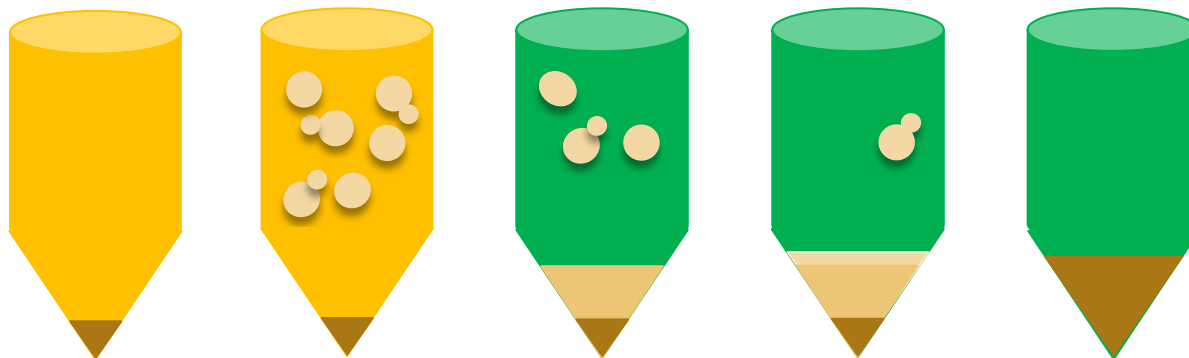
# Repitching: Can I repitch from Dry Hopped Beers?

Early Dry Hop



**Not ideal** unless top cropping before pre-dry hop (See MBAA TQ with Jessica Young)

Mid-Late Dry Hop



**YES!** Time the dry hop for day 5-7 and you can still pull off yeast pre-dry hop