

# **Advanced Hop Oil Delivery - Comparing Formulation and Process Effects On Aroma Outcomes**

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# Today's Roadmap

- Trial 1: Emulsified vs. Non-Emulsified Hop Products at Equivalent Cost
- Trial 2: Replacing T-90 Whirlpool Additions with Equivalent HyperBoost in Fermenter



# **Trial 1:** Dry Hop Replacement – Emulsified vs. Non-Emulsified at Equivalent Cost

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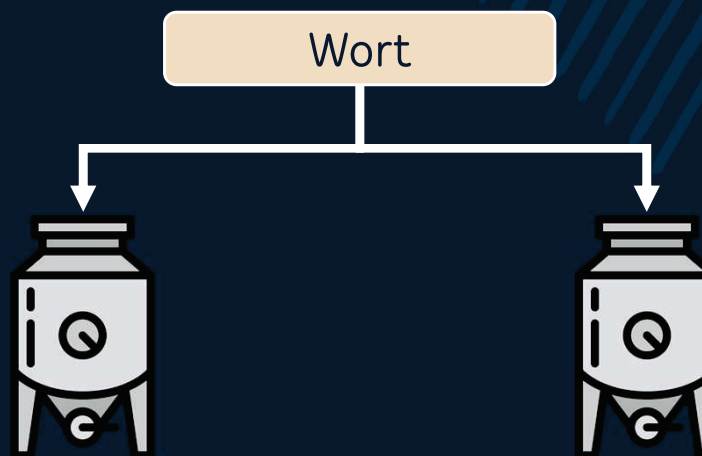
*How does replacing part of the dry hop with an equivalent cost of emulsified and non-emulsified products impact the beer?*



# Study Design

HyperBoost = Non-Emulsified Hop Oil (60% oil)

YCH 805 = Emulsified Hop Oil Product (2% oil) with propylene glycol



HyperBoost Addition  
@ D2

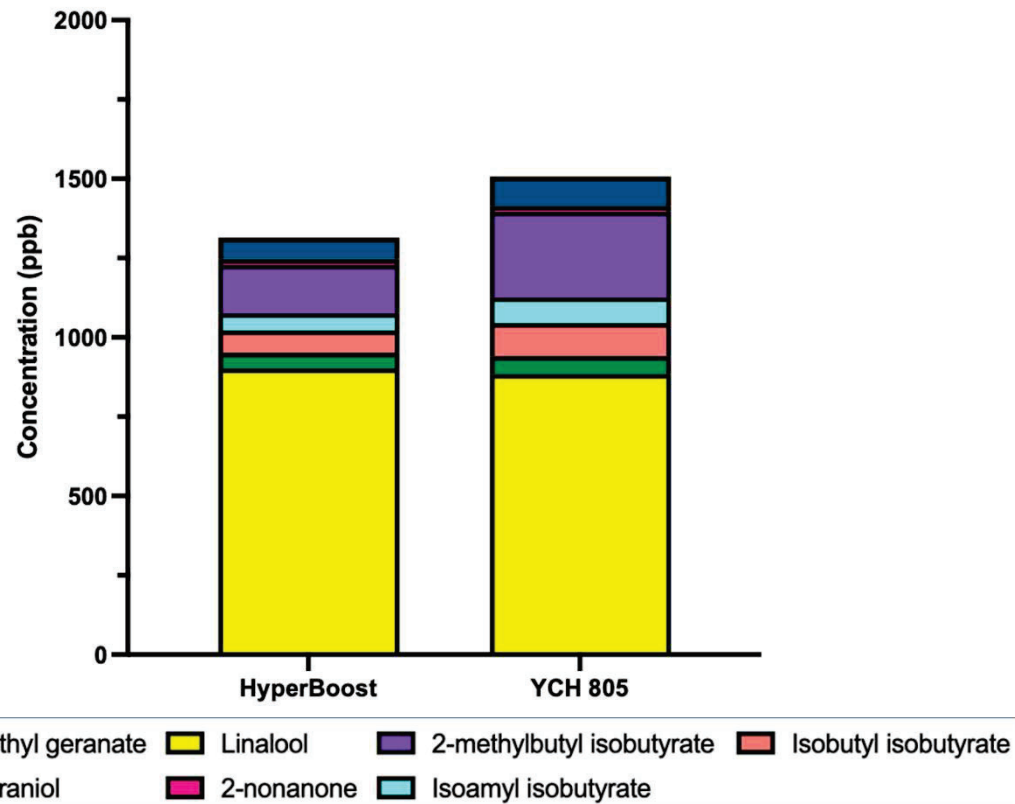
| Variety  | % of DH | DH Rate (g/L) | DH Rate (lbs/bbl) |
|----------|---------|---------------|-------------------|
| Citra    | 24%     | 2.0           | 0.5               |
| Krush    | 42%     | 3.5           | 0.9               |
| Mosaic   | 24%     | 2.0           | 0.5               |
| Citra HB | 10%     | 0.9           | 0.2               |
| Total    | 100%    | 8.4           | 2.1               |

YCH 805 Addition @  
Package

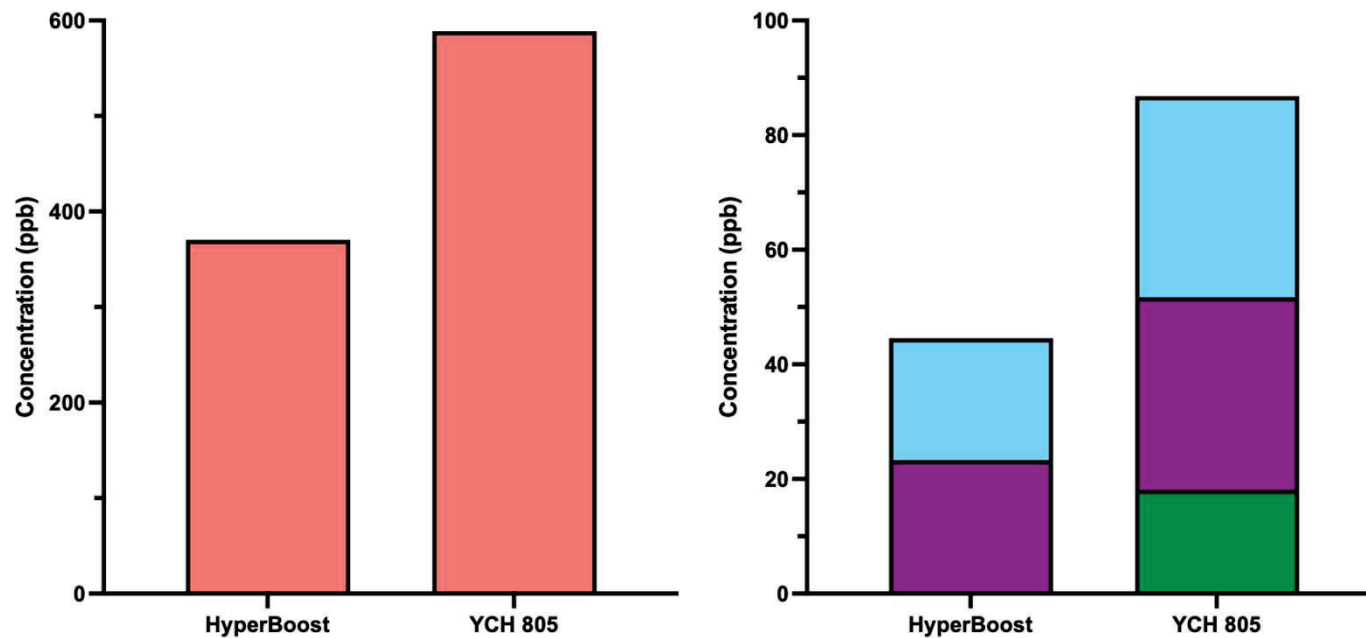
| Variety   | % of DH | DH Rate (g/L) | DH Rate (lbs/bbl) |
|-----------|---------|---------------|-------------------|
| Citra     | 20%     | 2.0           | 0.5               |
| Krush     | 35%     | 3.5           | 0.9               |
| Mosaic    | 20%     | 2.0           | 0.5               |
| Citra 805 | 25%     | 2.5           | 0.6               |
| Total     | 100%    | 10            | 2.5               |

YCH 805 replaced 25% of dry hop. The equivalent cost was calculated for HyperBoost to dose in separate batch.

# Emulsification Shifts Ester Profile, Not Linalool Content

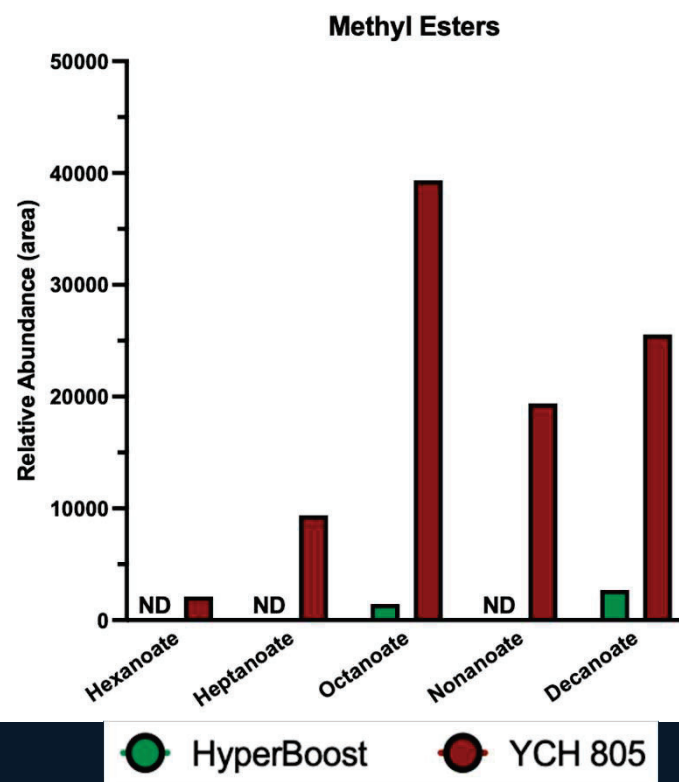


# Emulsification Increases Terpene Abundance

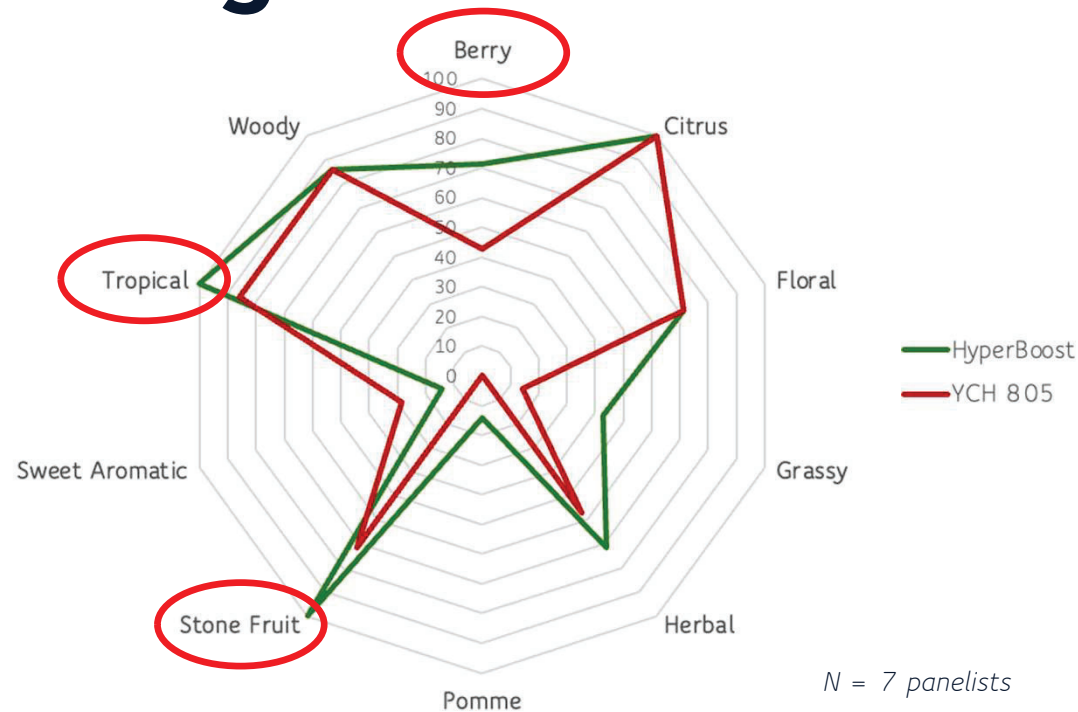


Myrcene Humulene Caryophyllene Farnesene

# Emulsification Increases the Abundance of Hop-Derived Methyl Esters

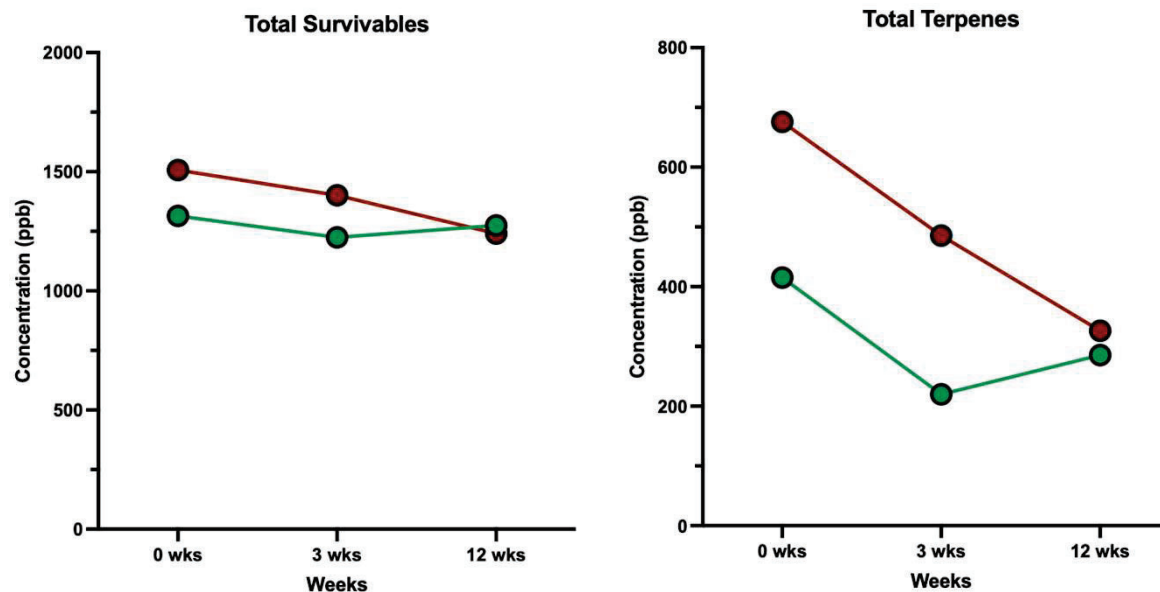


# HyperBoost Elevates Fruit-Forward Notes; Diverges on Herbal/Grassy



# Survivables & Terpenes- Changes Over 12 Weeks

Samples were packaged into 16 oz cans and stored in a cold room for 12 weeks



*Survivables include isobutyl isobutyrate, isoamyl isobutyrate, 2-methylbutyl isobutyrate, linalool, geraniol, 2-nonanone, and methyl-geranate.*

*Terpenes include myrcene, trans-caryophyllene, humulene, and farnesene.*



HyperBoost



YCH 805



**HOP &  
BREW  
SCHOOL**

# Trial 1 Takeaways

- Emulsification changes the composition, not just concentration – *despite lower total hop oil, emulsification plays a significant role in solubilizing compounds not previously easily solubilized in beer (terpenes, methyl esters)*
- Changes in aroma compound compositions due to emulsification can impact the final sensory – *more soluble compounds in the beer can potentially result in masking potential high-impact aromas*
- Emulsification leads to greater changes in aromatic compound concentrations over time for select compound classes – *strong shifts in specific aromatic compounds (e.g., survivables, fatty acid esters) have the potential to meaningfully change the sensory profile as the product ages*



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SCHOOL**

## **Trial 2:** Replacing 50% of Whirlpool T-90 with HyperBoost at Pitch

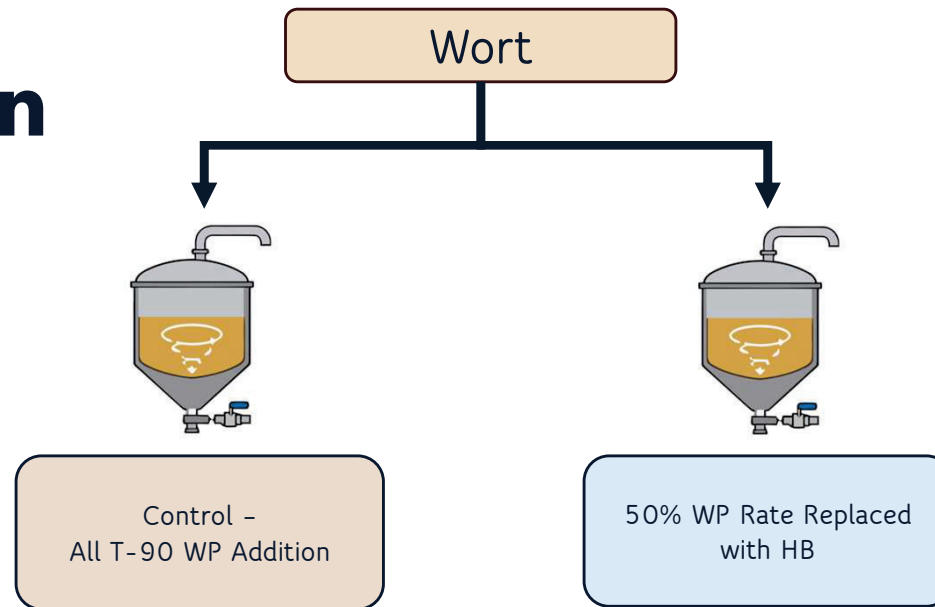
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*Can a 50% T-90 replacement at pitch reproduce the same aroma outcome as full T-90 at whirlpool – or does it produce a functionally different result?*



# Study Design

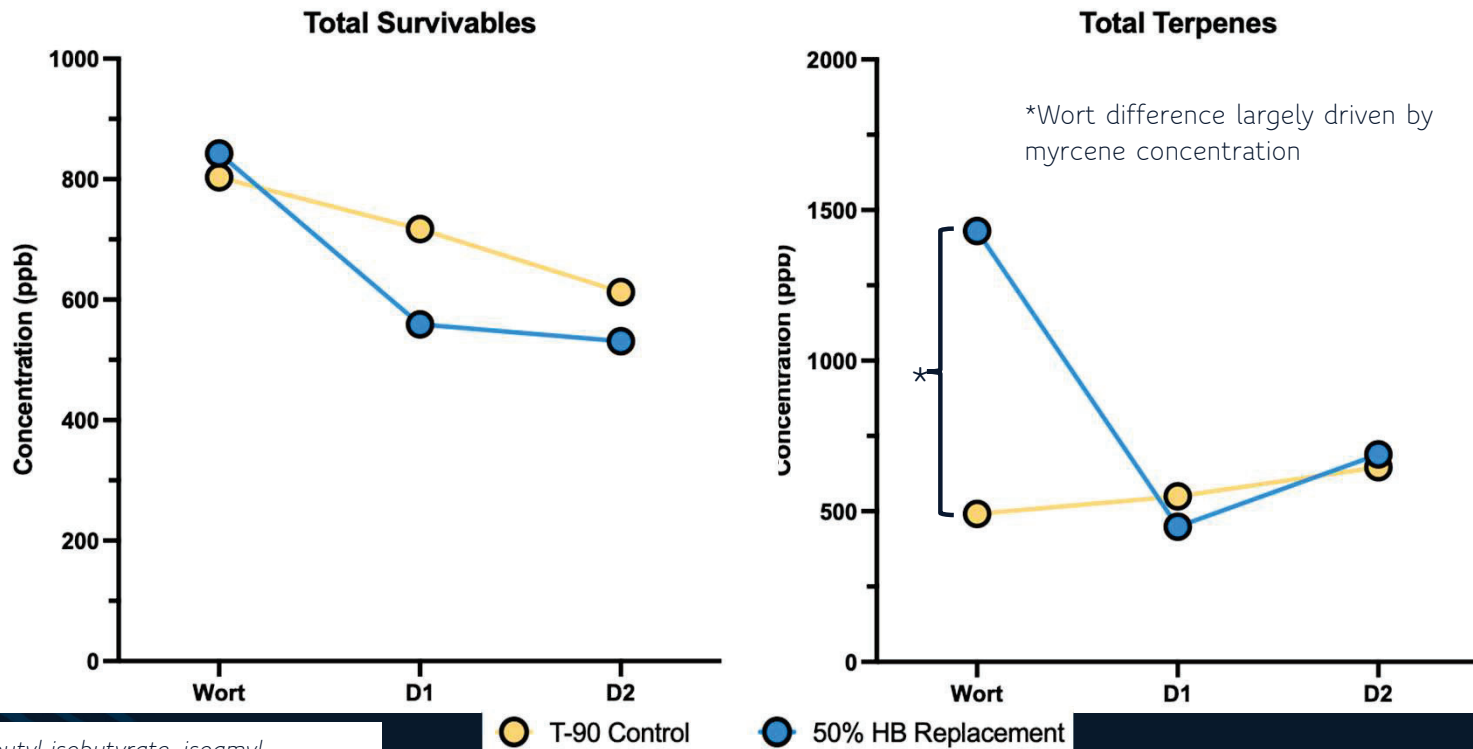
Both batches received the same dry hop on Day 2 of fermentation (10 g/L ; 2.6 lbs/bbl) of Citra, Mosaic, Krush.



| Variety | Timing | WP Rate (g/L) | WP Rate (lbs/bbl) |
|---------|--------|---------------|-------------------|
| Citra   | WP     | 3.3           | 0.8               |
| Simcoe  | WP     | 2.2           | 0.6               |
| Total   | 100%   | 5.5           | 1.4               |

| Variety  | Timing     | WP Rate (g/L) | WP Rate (lbs/bbl) |
|----------|------------|---------------|-------------------|
| Citra    | WP         | 0.6           | 0.2               |
| Simcoe   | WP         | 2.2           | 0.6               |
| Citra HB | FV @ Pitch | 2.7           | 0.7               |
| Total    | 100%       | 5.5           | 1.5               |

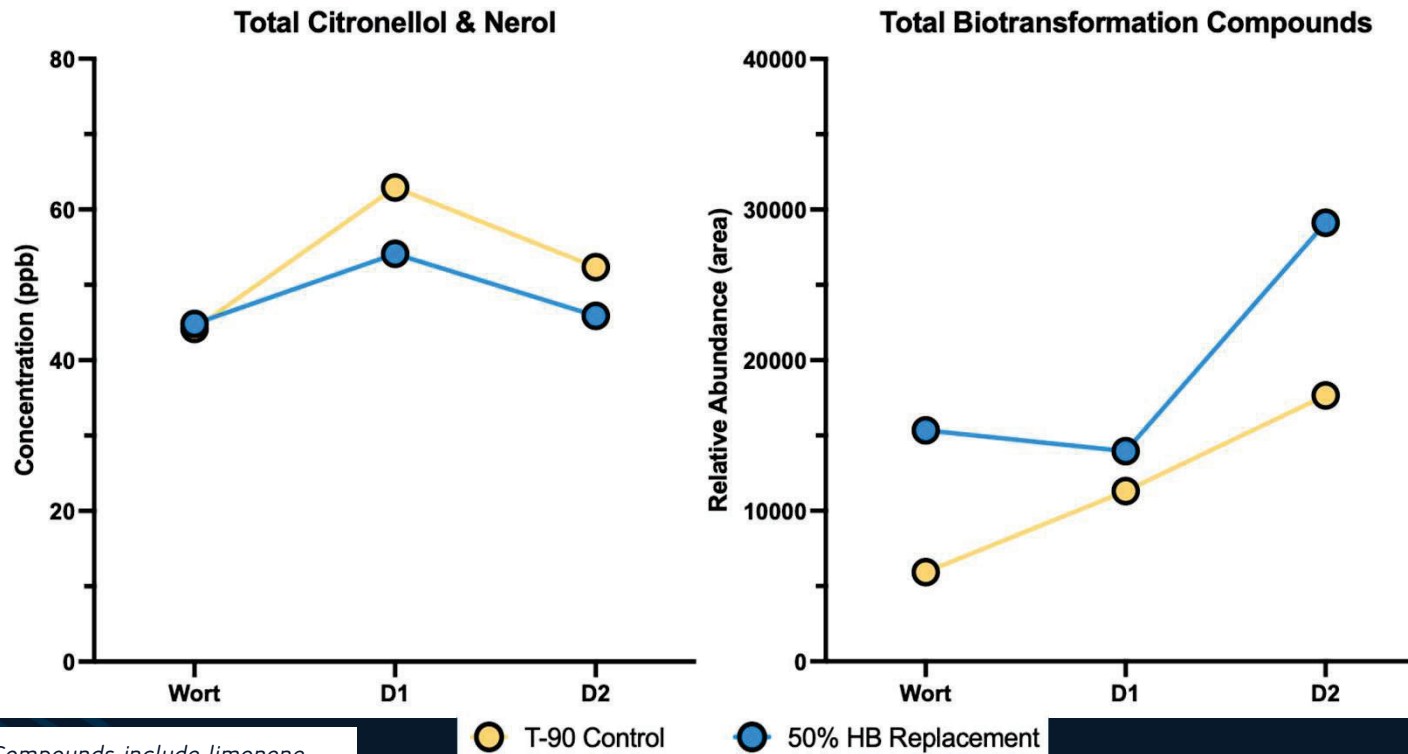
# Terpenes Recover Fully by Day 2; Survivables Trend Toward Control



*Survivables include isobutyl isobutyrate, isoamyl isobutyrate, 2-methylbutyl isobutyrate, linalool, geraniol, 2-nonanone, and methyl-geranate.*

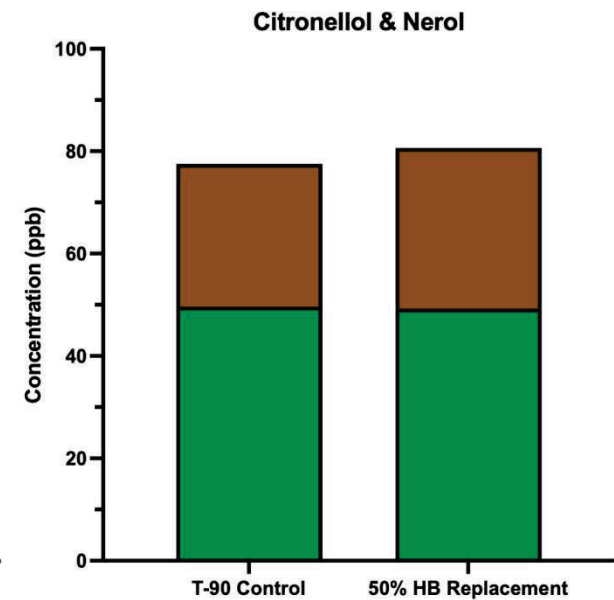
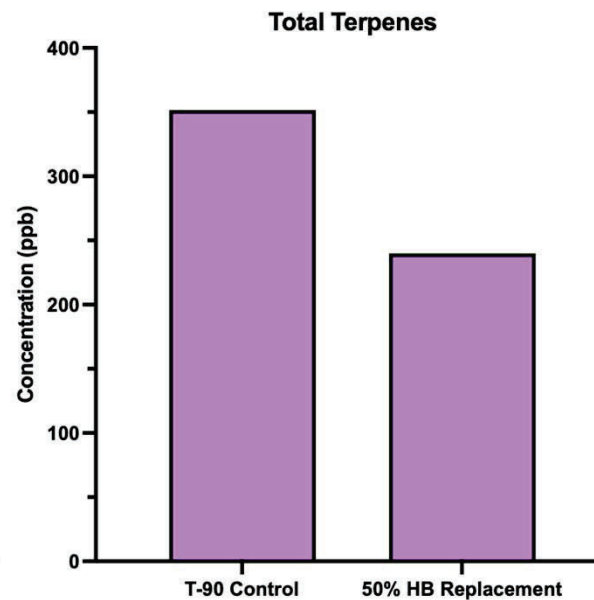
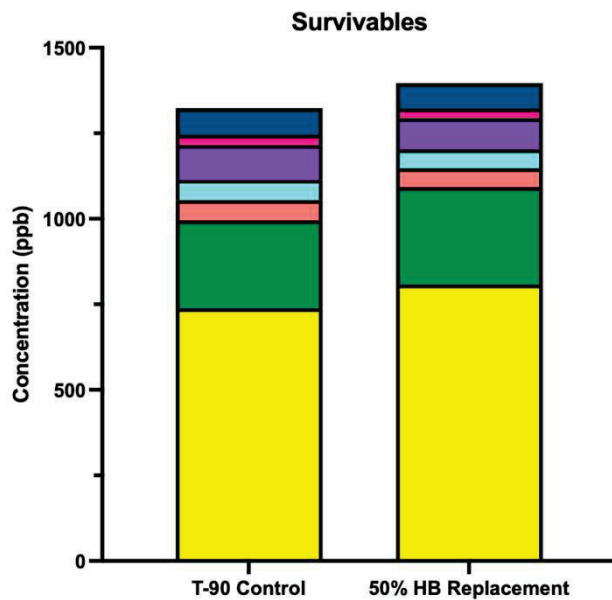
*Terpenes include myrcene, trans-caryophyllene, humulene, and farnesene.*

# Citronellol & Nerol Remain Comparable; Biotransformation Compounds Trend Higher with HB by Day 2



Total Biotransformation Compounds include limonene, citronellyl acetate, geranyl acetate, neryl acetate

# 50% HyperBoost Replacement - Similar Survivables and Biotransformation Compounds, Lower Terpenes



■ Methyl geranate ■ Linalool ■ 2-methylbutyl isobutyrate ■ Isobutyl isobutyrate  
■ Geraniol ■ 2-nonanone ■ Isoamyl isobutyrate

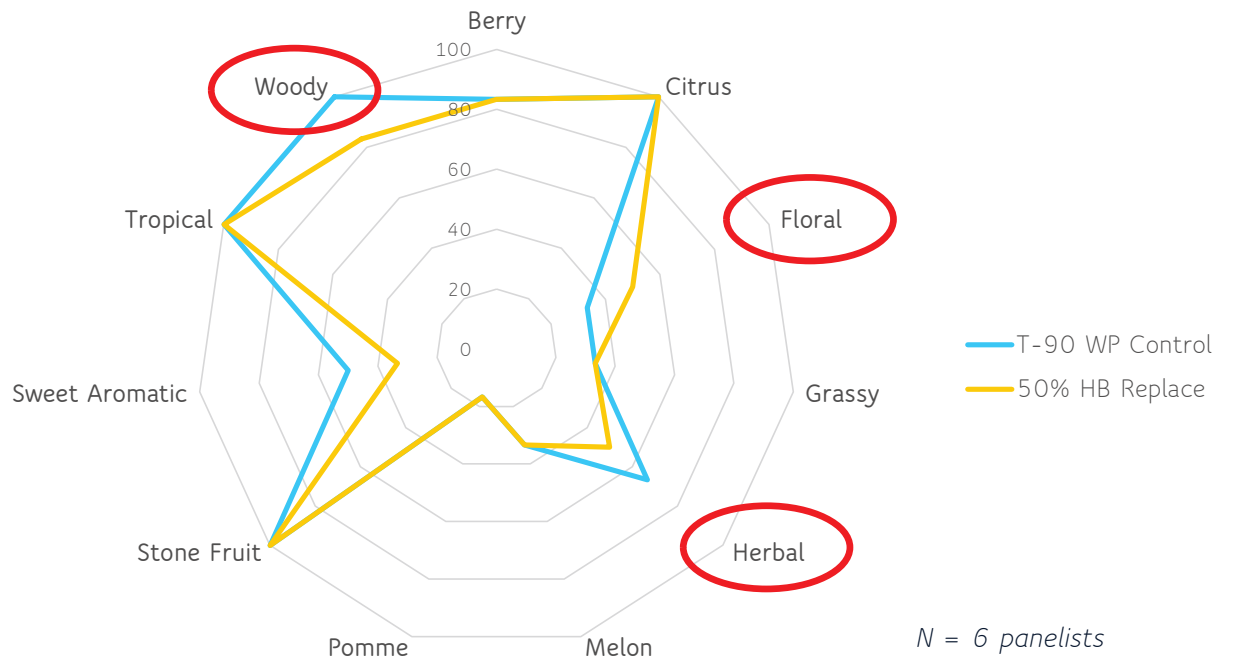
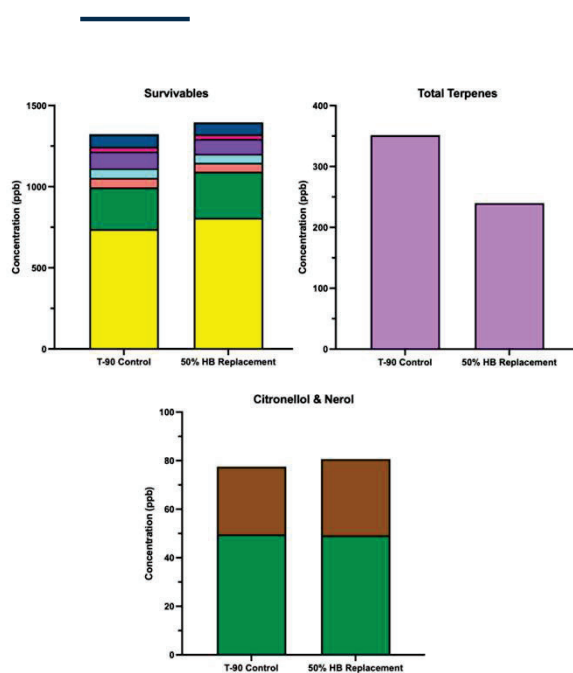
*Terpenes include myrcene, trans-caryophyllene, humulene, and farnesene.*

■ Citronellol ■ Nerol



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# 50% HyperBoost Replacement - Increased Perceivable Floral with Decreased Woody and Herbal Attributes



# Trial 2 Takeaways

- A 50% T-90 substitution with HyperBoost at pitch doesn't significantly alter core hop character by Day 2 – *Survivables and terpenes both trend back toward parity with the full T-90 control after a transient dip during active fermentation.*
- HyperBoost substitution at pitch may provide more complexity rather than replicating the T-90 control – *Biotransformation compounds end up net-elevated relative to control by Day 2.*
- Replacing 50% of T-90 in whirlpool with HyperBoost at pitch produces similar levels of survivable and biotransformation compounds but much lower terpene concentrations – *Sensory analysis shows increased floral aromas and less perception of woody/herbal characteristics in HyperBoost replacement beer.*
- Removal of T-90 from the whirlpool may lead to greater wort yield – *1kg of hops absorbs about 10kg of wort/beer.*



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