Enhancing Thiols with Yeast

Laura Burns
Omega Yeast

HOP & BREW SCHOOL

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

Laura Burns
Director of R&D

w w w . o m e g a y e a s t . c o m

What are thiols?

Sulfur Compounds – think alcohol but instead of OH, SH

Tropical and citrus aromas (tropical fruits, hops)
Dank/skunky (weed, hops, coffee)

Very potent! Odor threshold in the parts per trillion

Characteristic aroma of Sauvignon blanc wines and certain hop varieties (Nelson Sauvin, Hallertau Blanc, Simcoe)

Thiols in Beer	Sensory	Threshold (ng/L)
4MSP (4MMP)	Box Tree, Black Current	1.5
3SH (3MH)	Grapefruit, Passion Fruit	60
3SHA (3MHA)	Passion Fruit	4
3S4MPol	Grapefruit, Rhubarb	40
3S4MPA	Grapefruit, Rhubarb	120

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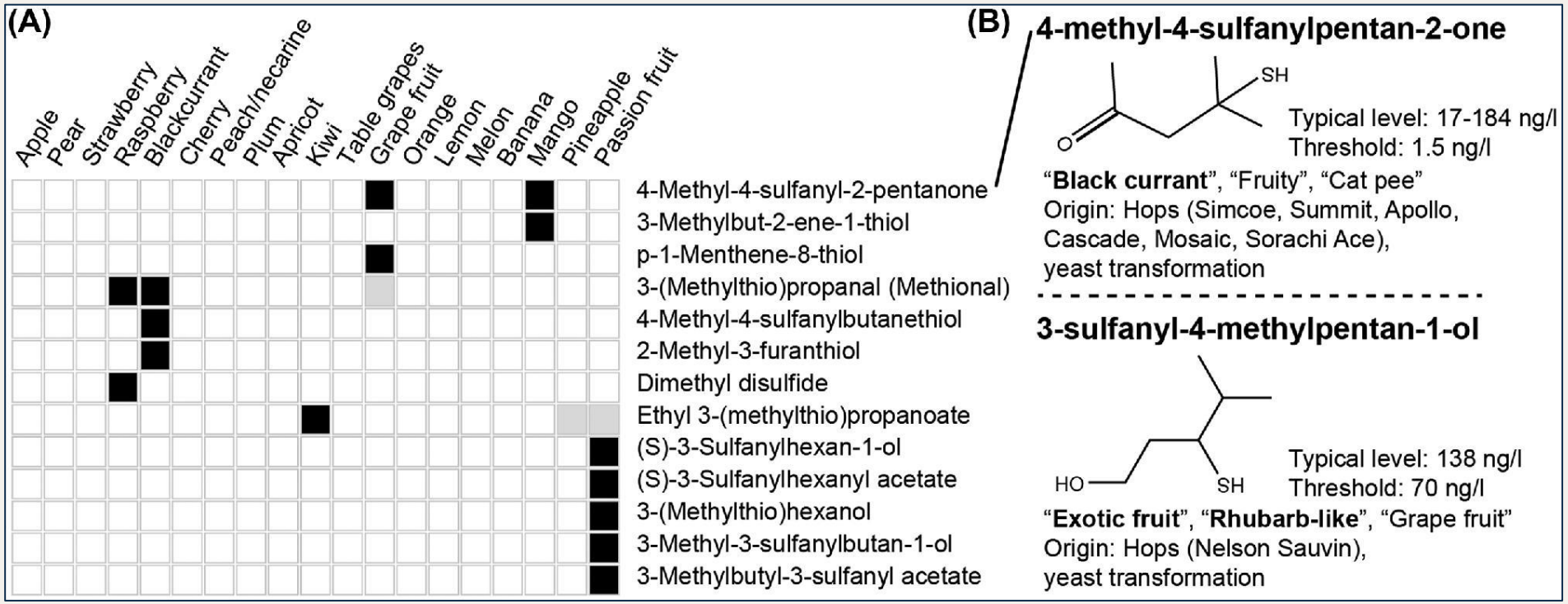
Thiols Found in Hops and Fruits



FEMS Microbiology Reviews 2019, 43,193-222; https://doi.org/10.1093/femsre/fuy041

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Thiols are very Odor Active

21,000 bbls (660,000 gal)

Parts per million (mg/L)

5 beers – 21 bbl
Esters, aldehydes

Parts per billion (ug/L)

2.5 ml - 5 beers
Diacetyl

Parts per trillion (ng/L)

2.5 ul – 2.5 ml
Thiols

OMEGA YEAST

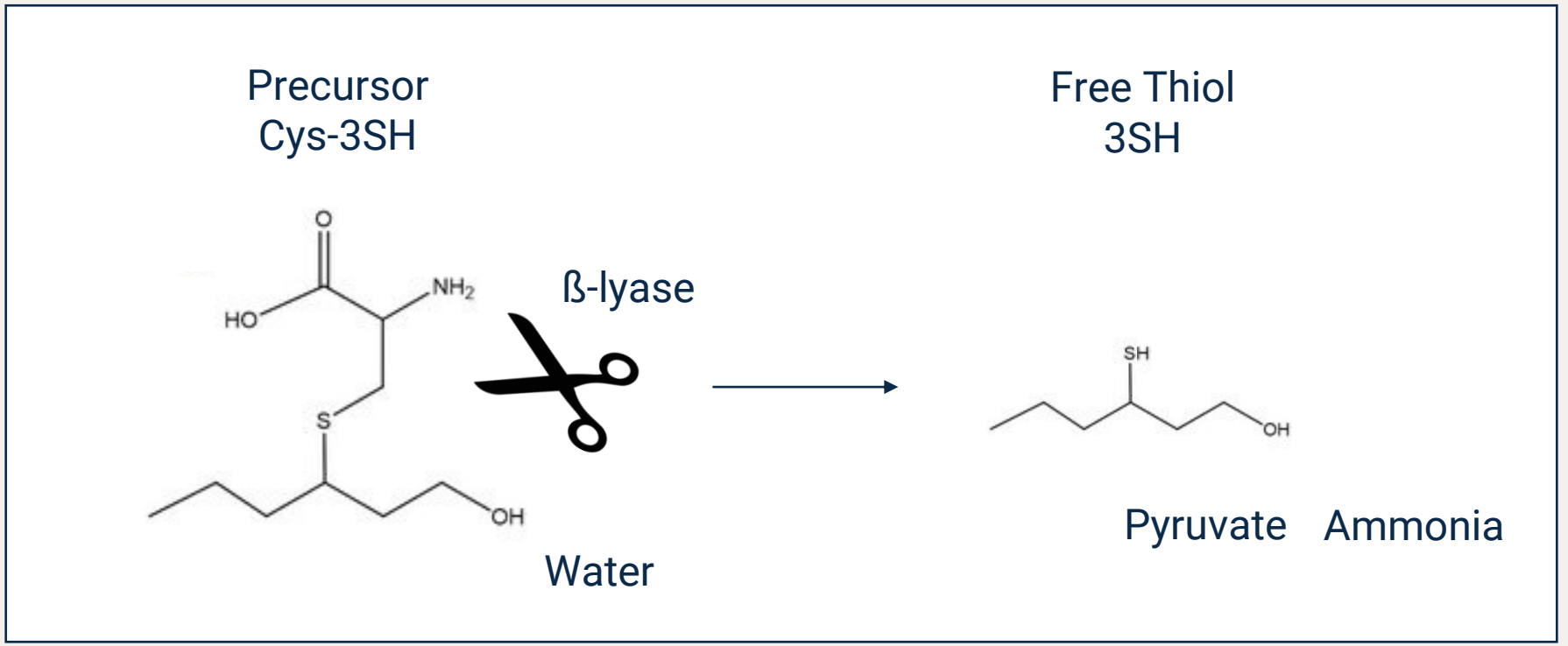
Thiols are very Odor Active

Thiols in microliter amounts

21,000 bbls (660,000 gal)

Polyfunctional Thiol	Sensory	Threshold (ng/L)	ul into the pool
4MSP (4MMP)	Box Tree, Black Current	1.5	3.75 ul
3SH (3MH)	Grapefruit, Passion Fruit	60	150 ul
3SHA (3MHA)	Passion Fruit	4	10 ul
3S4MPol	Grapefruit, Rhubarb	40	100 ul
3S4MPA	Grapefruit, Rhubarb	120	300 ul

Thiol Biotransformation



ß-lyase enzyme (carbon-sulfur lyase): cleaves the thiol precursor to release the free thiol

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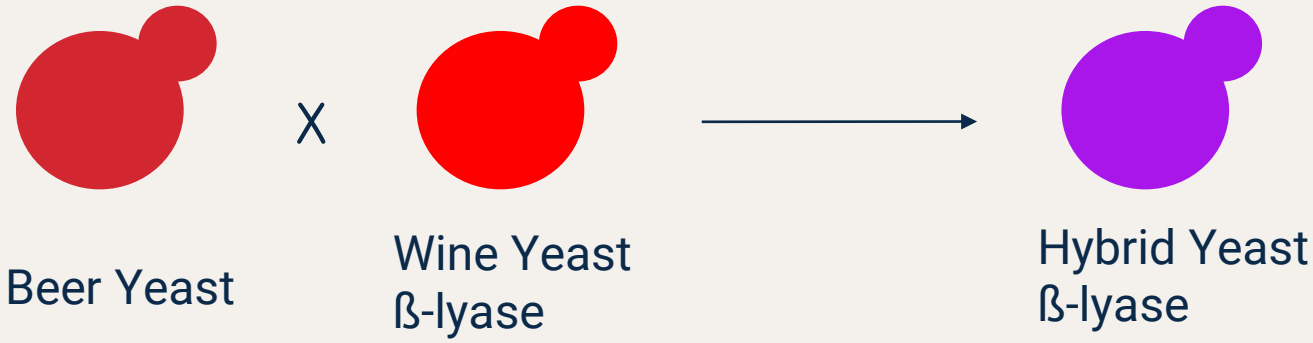
YEAST HYBRIDS

Failed to Significantly Increase Thiols in Beer

1. Wine strains with high ß-lyase activity used to ferment beer.
2. Crossing wine strains with beer strains.
   Vin13 x Saison
   Maxithiol x Hazy IPA strain



Why didn't this work?

- Nitrogen levels in beer are in excess
- Low/no IRC7 expression

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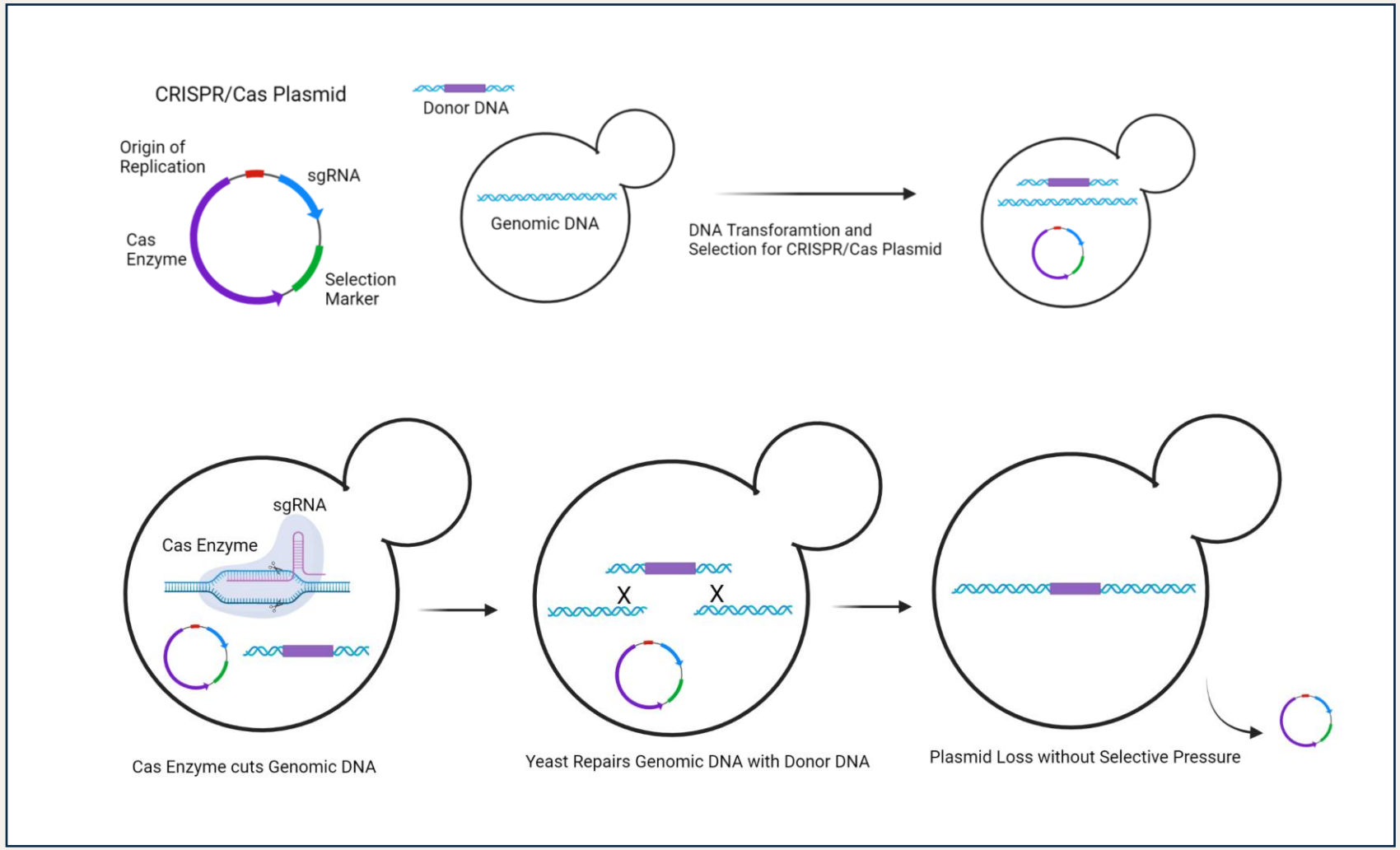
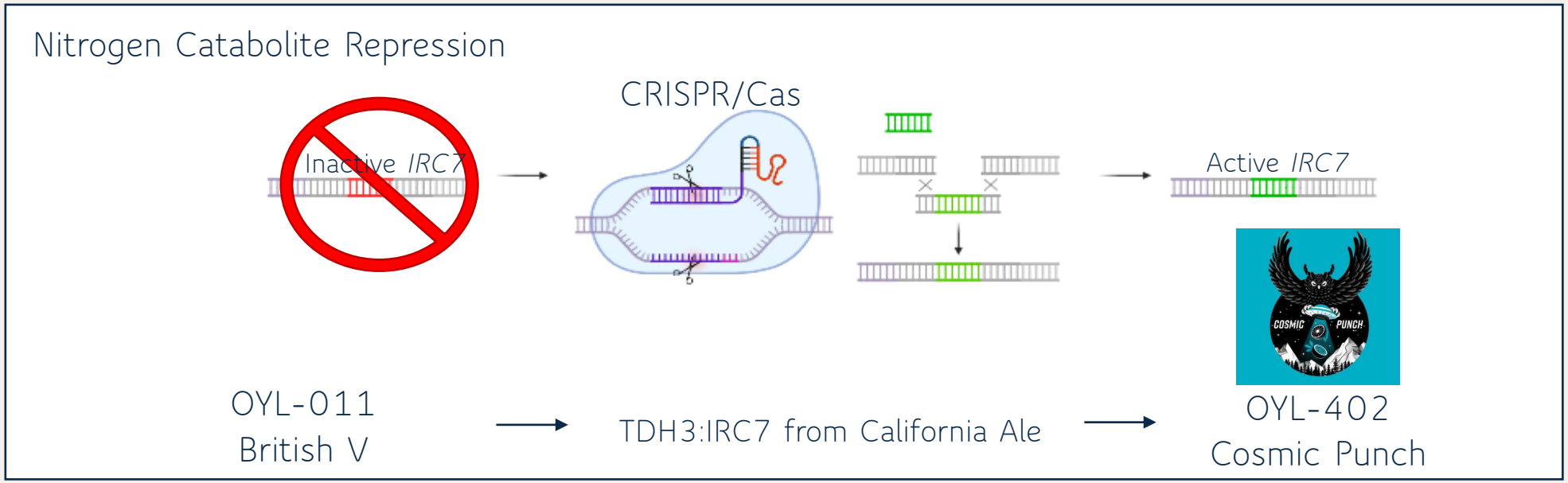
How we use CRISPR/Cas to engineer brewing yeast



OMEGA YEAST

Thiolized™ Yeast
Cosmic Punch: *IRC7* gene



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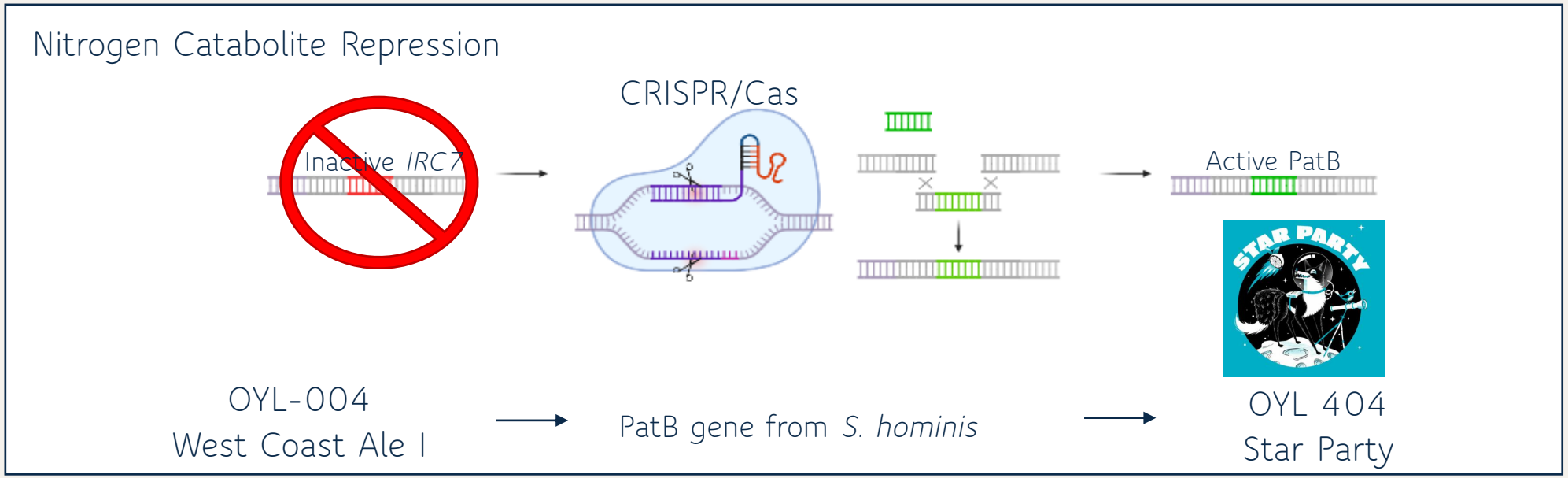
Thiolized™ Yeast
Star Party, Lunar Crush, Helio Gazer: PatB gene



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Thiolize™ brewing strains

+

Thiolized Yeast with
ß-lyase Enzyme

=

THIOLS!

1. Cosmic Punch (Irc7)
2. Star Party, Lunar Crush and Helio Gazer (PatB)

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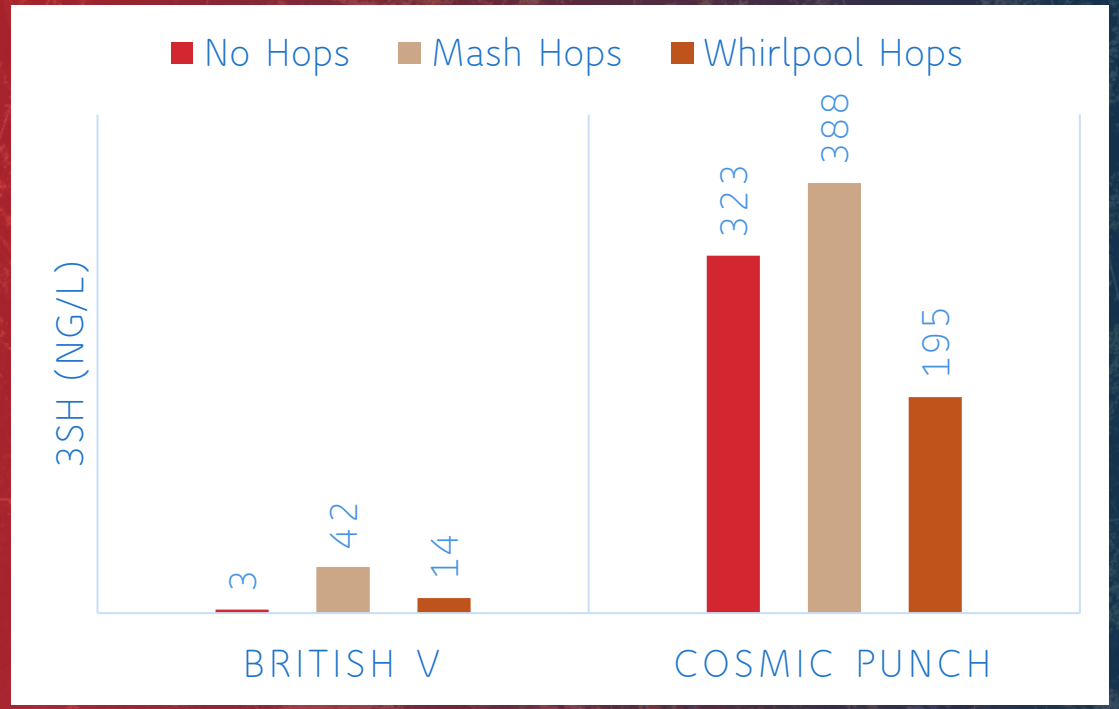
Mash Hopping

Potential for more thiols



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Things to Consider When Mash Hopping

You will get bitterness from mash hopping

- 30% of the IBU levels that you would expect from a beginning of boil addition.
- Addition rates between 0.5 lb/bbl to 2 lb/bbl depending on the alpha acid content of the hop

Avoid expensive aroma hops

- Other volatile hop aroma compounds will be lost in the boil and beginning of fermentation.

Advice for Maximizing Thiols

Hopping methods

- *Mash hopping!*
- *Try alternative hop products in the whirlpool – Cryo Hops®, Incognito™, and Salvo™…*
- *Heavy whirlpool and dry hop additions reduce the impact of thiols*

The majority of the precursors come from the malt

- *Barley – little from oats/wheat/rice*
- *Play with different base malts/ malt varieties - terroir*
- *Higher kilned malts may have less precursor*

Try other sources of thiol precursor

- *Phantasm – wine grapes*
- *Possibly other fruit sources*

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Cosmic Punch vs. Helio Gazer

Strain	Parent Strain	B-lyase	Thiol output?	Best uses?
Cosmic Punch	OYL-011	Irc7	10x sensory threshold	Enhance thiol notes, NEIPA or hazy IPAs, house strain that can be versatile
Helio Gazer	OYL-011	PatB	300x sensory threshold	Intense thiol aromas, stands out in heavily hopped beer styles

Cosmic Punch

Helio Gazer

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What's next?

Learning more about raw materials:

- *Thiol precursors in different malts*
- *Hop varieties that pair well with Thiolized™ yeast*
- *Mash hopping best practices*
- *Advanced hop products for the whirlpool and dry hopping*
- *Making use of regional malts and hops*

New approaches to making thiol-focused beer:

- *Finding the balance of thiols and hop aroma*
- *Cold IPAs, NEIPAs, WC IPAs, and what else?*

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THANK YOU!

Questions? laura@omegayeast.com

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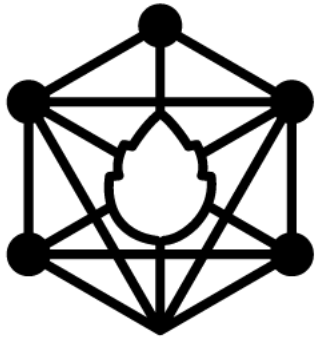
Phantasm

UNLOCK
UNREAL
NATURAL
FLAVOURS

Natural Thiol Precursors for the World's Best Brewers

GARAGE PROJECT

ARO ST
WELLINGTON



HĀPI

HOP RESEARCH CENTRE

Phantasm

Marlborough Terroir

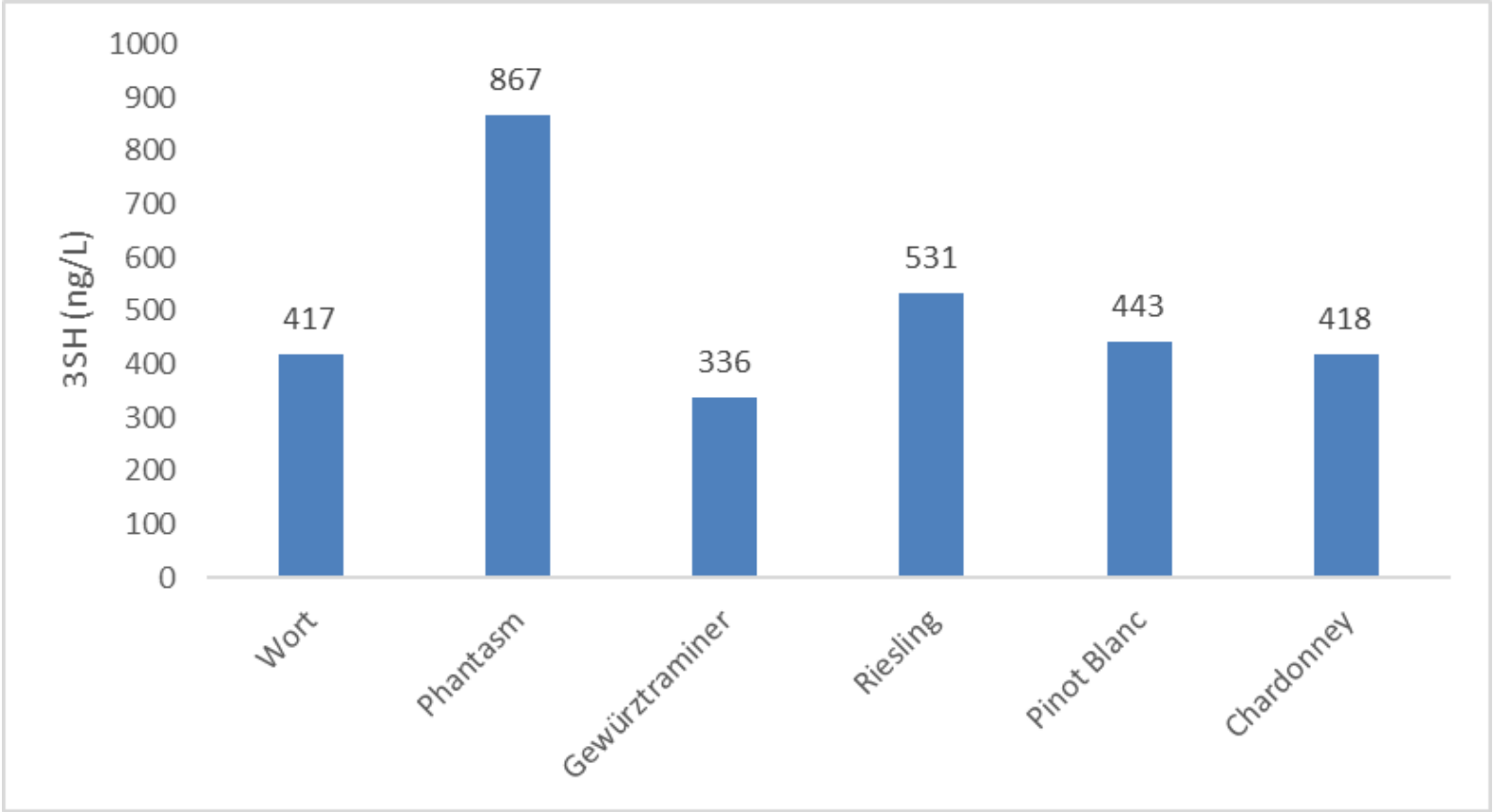
Marlborough Sauvignon Blanc - a perfect Thiol eco-system

Huge investment from New Zealand Government

Vineyard management, harvesting methods, winery handling - all driven around increasing thiols

Results in up to 20,000ng/l of 3SH in some wines

Marlborough Terroir



Phantasm Precursors

Sourced from blocks with historic punchy precursor levels

Rich in cys-3SH

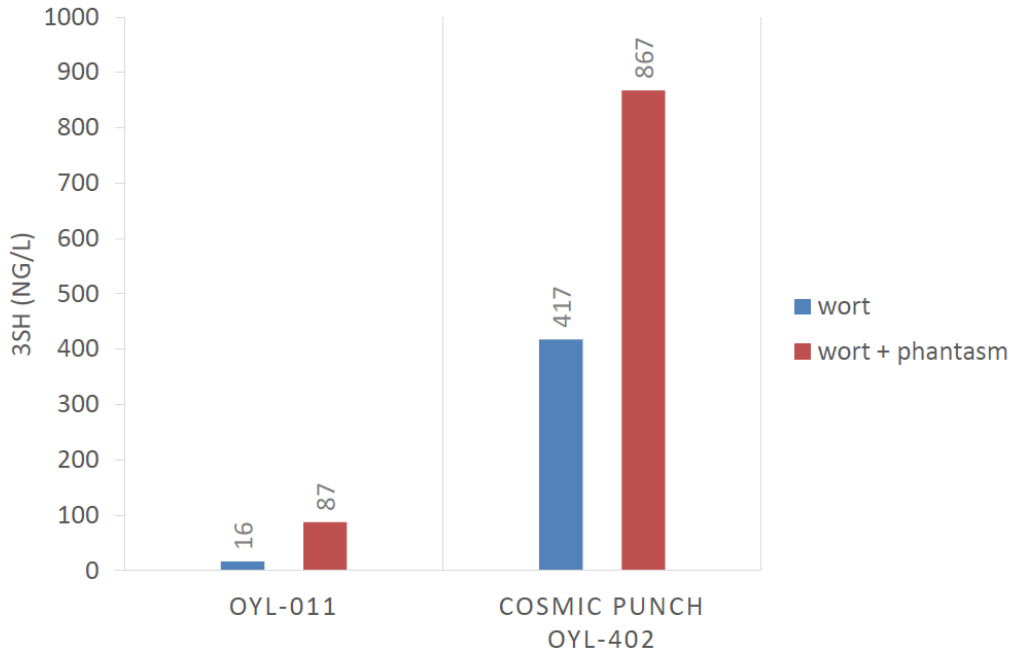
In the right fermentation conditions, converts to high levels of 3SH (800 - 2,000ng/l

3SHA more elusive, but have observed north of 120ng/l in fermentation

Won’t contribute to 3S4MPOL or 4MSP alone but levels increase with hops

Phantasm Precursors

COSMIC PUNCH AND PHANTASM PUSH 3SH LEVELS THROUGH THE ROOF



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Phantasm

Accio Phantasm!

Humble Sea Brewing Company

IPA - New England / Hazy

TOTAL (?)	UNIQUE (?)
74	72
MONTHLY (?)	YOU
0	0

7.5% ABV	No IBU	(3.3)	68 Ratings

Hopless IPA No hops! Only science + Phantasm

Nedaniner T. is drinking an Accio Phantasm! by Humble Sea Brewing Company at Untappd at Home

Hop farmers, you have nothing to worry about!

Purchased at **Humble Sea Brewing Co.**

Can

Tagged Friends

Phantasm


Bart Shrimpson
DDH FOGGY DIPA WITH
8%
SEA
HUMBLE SEA BREWING CO.


SHRED FLANDERS
TDH HOP FUSED TIPA 10.4%
SEA
HUMBLE SEA BREWING CO.

Phantasm

Bart Shrimpson

Humble Sea Brewing Company

IPA - Imperial / Double New England / Hazy

TOTAL (?)	UNIQUE (?)
436	416
MONTHLY (?)	YOU
0	0

8% ABV	No IBU	(4.09)	377 Ratings

TDH Foggy DIPA with Phantasm triple dry-hopped with Citra and Riwaka

Shred Flanders

Humble Sea Brewing Company

IPA - Triple New England / Hazy

TOTAL (?)	UNIQUE (?)
305	287
MONTHLY (?)	YOU
1	0

10.4% ABV	No IBU	(4.13)	262 Ratings

Triple Dry-Hopped TIPA hop-fused with Phantasm, Mosaic, Vic Secret, Centennial, and Motueka

Tom K. is drinking a Shred Flanders by Humble Sea Brewing Company at Humble Sea Brewing Co.

Holy damn fuc$ you Rick

Draft

Earned the Tripping on TIPAs (Level 23) badge!

Tagged Friends

Phantasm

Entourage Effect

Phantasm & Hops are BFFs

Thiols + Terpenes + Esters

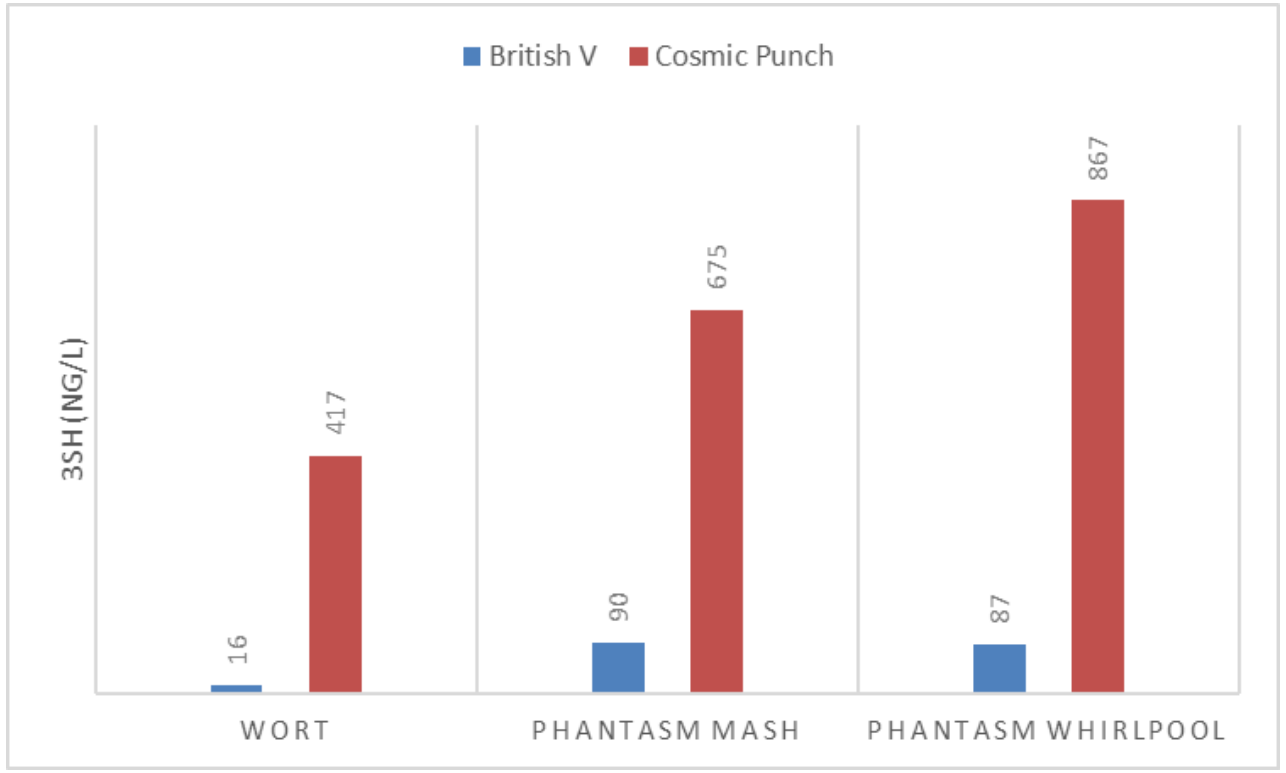
All critical components to a well rounded Sauvignon Blanc

Remove Esters and ‘sweet sweaty passionfruit’ drops - thought to be linked to Thiols

Remove Linalool and there is a massive difference

Brewing Tips

Whirlpool Addition



Brewing Tips

Complementary hot side hop additions - complex interactions we don’t yet understand

Strategic dry hop additions

Consider other techniques - tank blending

Explore a wider range of styles - Lager, Mix Ferm, Cider, Non Alc

Where to?

Experimental - ongoing R&D

Further work to understand Hop / Yeast / Phantasm interactions

New Thiol Yeast strains and non GMO strains

Dedicated Phantasm production plant

‘Next Gen’ Phantasm - 36x current precursor levels

Phantasm

UNREAL NATURAL FLAVOURS FROM NEW ZEALAND


Phantasm

Yakima Chief Hops

Future Survivables Initiatives

YCH Trial 301 – Frozen Fresh Hop Cryo Pellets

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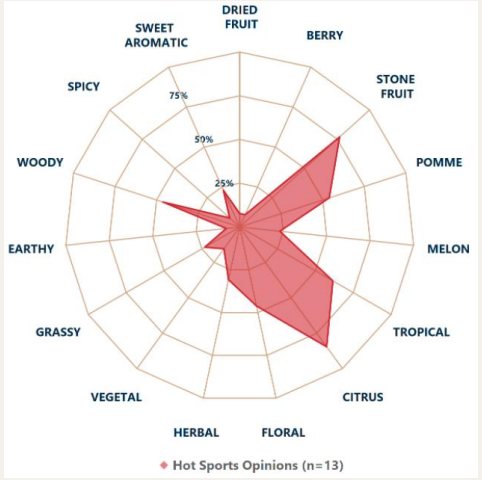
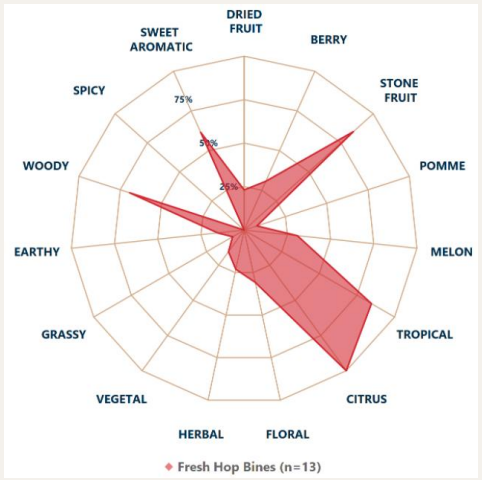
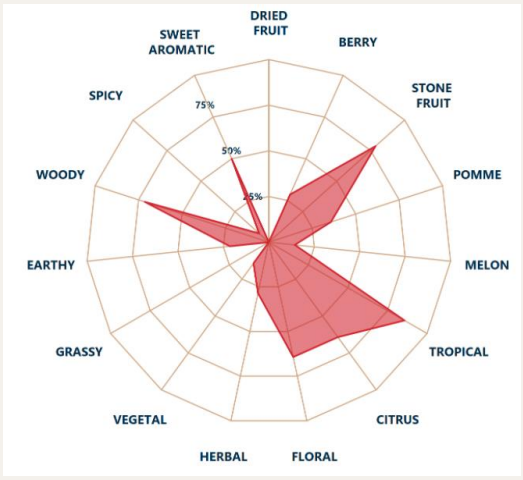
- High Sensory Impact
- Head Retention Improvements
- New Compounds?
- No presence of oxidized oils like sesquiterpene oxides since no heat is ever applied



Attribute	FFHC
PEACH	50.00%
HONEY	35.71%
PINEAPPLE	35.71%
LEMON	28.57%
PINE	28.57%
APPLE	21.43%
CHERRY BLOSSOM	21.43%
CREAMY	21.43%
GRAPEFRUIT	21.43%
GUAVA	21.43%
MANGO	21.43%
PEAR	21.43%
ROSE	21.43%
BANANA	14.29%
CEDAR	14.29%
CHERRY	14.29%
COCONUT	14.29%
ORANGE	14.29%
PLUM	14.29%
VANILLA	14.29%



Attribute	Hot Sports Opinions
LEMON	46.2%
APPLE	30.8%
GRAPEFRUIT	30.8%
PINEAPPLE	30.8%
BUBBLEGUM	23.1%
GUAVA	23.1%
PINE	23.1%
APRICOT	15.4%
CHERRY	15.4%
MANGO	15.4%
PEAR	15.4%
ROSE	15.4%
SOAPY	15.4%



Attribute	Fresh Hop Bines
ORANGE	61.5%
PEACH	53.8%
MANGO	46.2%
PINE	38.5%
LEMON	30.8%
PINEAPPLE	30.8%
CREAMY	23.1%
GRAPEFRUIT	23.1%
PASSION FRUIT	23.1%
CANTALOUPE	15.4%
CEDAR	15.4%
CHERRY BLOSSOM	15.4%
GUAVA	15.4%
RESINOUS	15.4%
STRAWBERRY	15.4%
VANILLA	15.4%

YCH Trial 701 – Cold-Side-Friendly High Oil Extract

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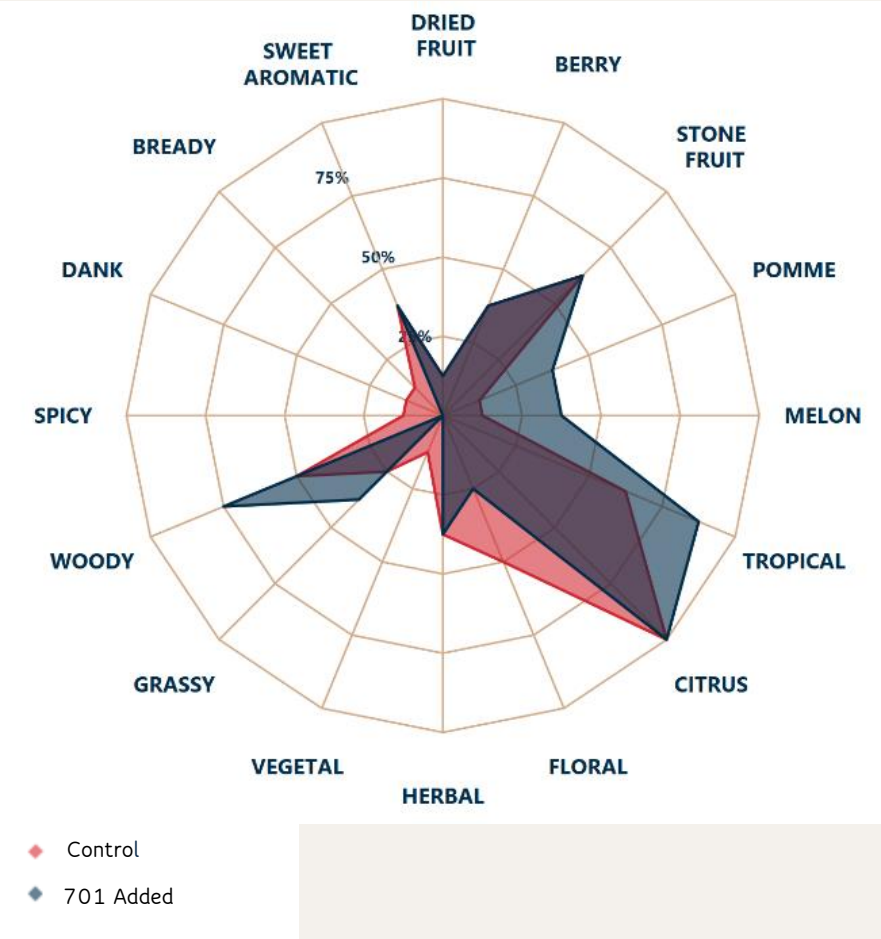
- Late process Survivables boost
- Potential to add compounds that would otherwise leave solution during brewing



Attribute	Control
APRICOT	37.5%
CEDAR	37.5%
ORANGE	37.5%
PINEAPPLE	37.5%
BANANA	25.0%
LEMONGRASS	25.0%
PINE	25.0%
SOAPY	25.0%

Attribute	701 Added
PINE	50.0%
BANANA	37.5%
GRAPEFRUIT	37.5%
LEMON	37.5%
PINEAPPLE	37.5%
APPLE	25.0%
APRICOT	25.0%
BUBBLEGUM	25.0%
CANTALOUPE	25.0%
CEDAR	25.0%
GREEN GRASS	25.0%
GUAVA	25.0%
ORANGE	25.0%
PEACH	25.0%
PLUM	25.0%

Survivables Evolution

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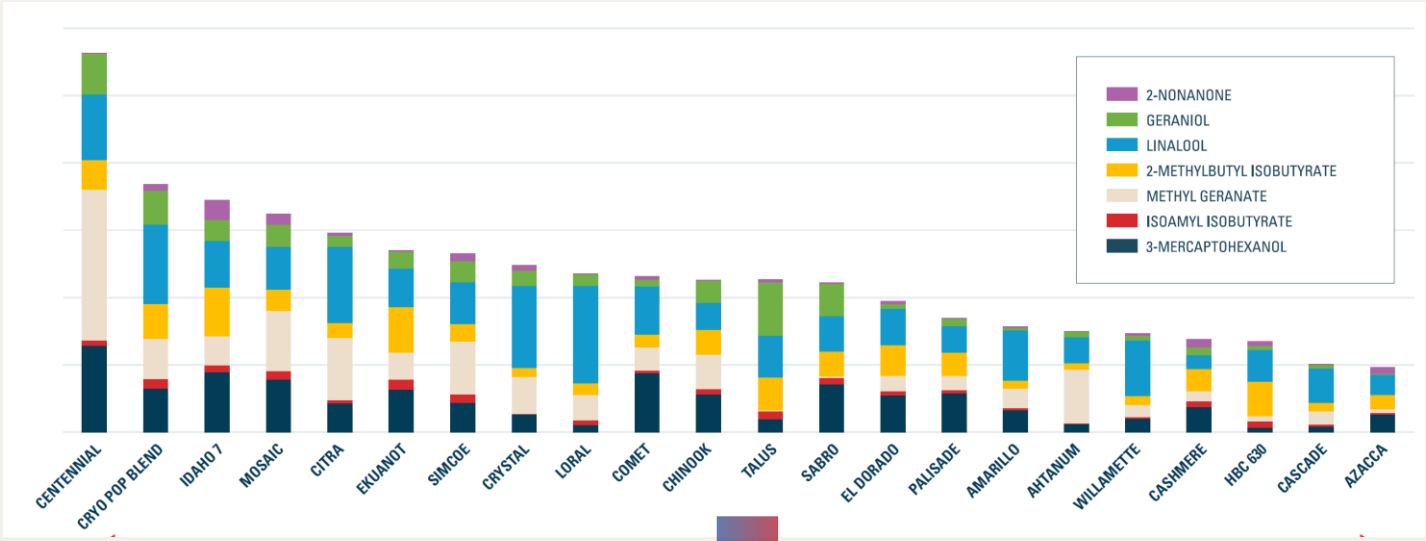

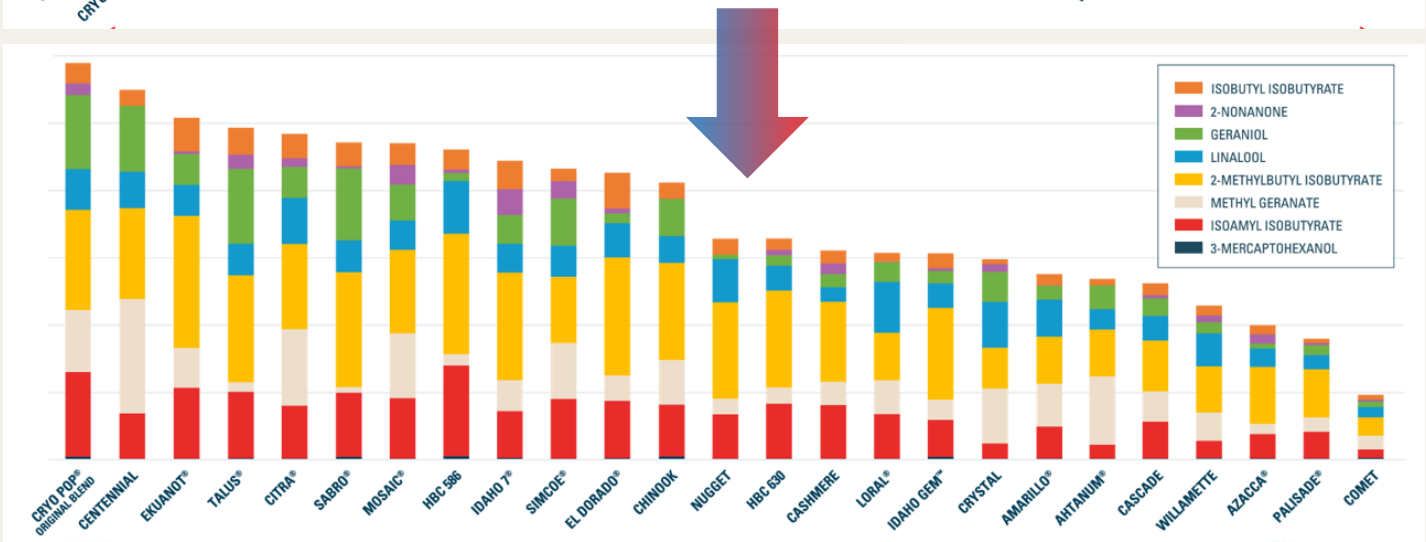

THANK YOU!

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