

The Lallemand logo, consisting of the word "LALLEMAND" in white, uppercase letters inside a red oval shape.

LALLEMAND

WORK SMARTER, NOT HARDER: PROCESS EFFICIENCY FOR BREWERS

Agraria Congress – April 2026

Sylvie Van Zandycke, Ph.D. President & General Manager

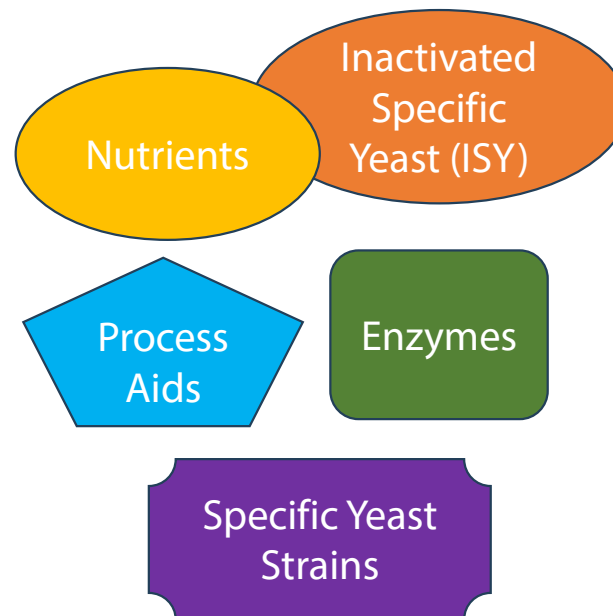
WE BREW WITH YOU®



GETTING THE MOST FROM YOUR BREW



Brewer's Toolkit



- ✓ Shorter Fermentation
 - ✓ Shorter Maturation
 - ✓ Greater Extract
 - ✓ Greater Yield / Reduced Losses
 - ✓ Reduced Wastage
 - ✓ Better Product Stability
 - ✓ Longer Shelf Life
 - ✓ Greater Consistency
- Use Less: ↓ Raw Materials
↓ Consumables
↓ Water
↓ Energy
- Use More or Continue Using:
↑ High Quality Ingredients
↑ Organic / Local Ingredients
↑ Adjuncts

OVERVIEW

1. MATERIAL EFFICIENCY

- Raw materials
- Reduce losses / Increase yields



2. TIME EFFICIENCY

- Mash & Lauter
- Fermentation and Maturation



3. ENVIRONMENTAL EFFICIENCY

- Energy reduction
- CO2 emissions



RAW MATERIALS: A FRACTION OF THE TOTAL BEER COST

Majority of the beer cost is related to packaging, labor, shipping, taxes, and other expenses.

Crafting exceptional beer requires quality ingredients.
Raw ingredients make up, on average, about 10% of total beer cost.*

Cost reduction can be achieved by assessing the entire brewing process as well as ingredients.

* Specific Cost Breakdown varies by region, brewery, and recipe.

Ingredients
(malt, hops, yeast)

10%



INGREDIENT COST BY BEER STYLE

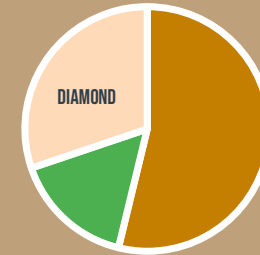
Malt makes up the majority of ingredients cost.

Yeast accounts for:

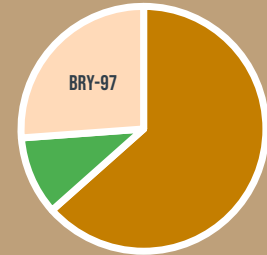
- **13-30% of ingredients cost**
- **1-3% of total beer production cost**



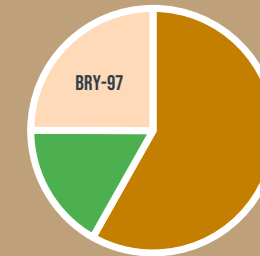
Bohemian Pilsner



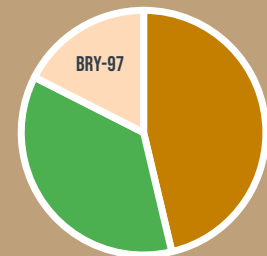
American Pale Ale



American IPA



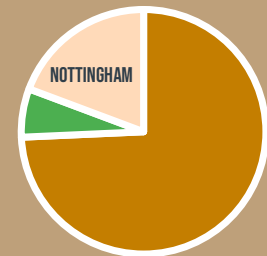
Imperial IPA



Weizen



Oatmeal Stout



Recipes based on: Zainasheff, J. and Palmer, J. (2007). *Brewing Classic Styles*. Brewers Publication. Price breakdown based on USA pricing, may vary by region.

MATERIAL EFFICIENCY: MALT

Enzymes

Beta Glucanase

Amylases

Inactive Specific Yeast (ISY)



ENZYMES

MATERIAL EFFICIENCY: MALT



Glucosidic Enzymes

Fungal α -Amylase: Glucogenic, Maltogenic

Glucoamylase: Glucogenic

Glucanases: Reduces non-starch polysaccharides (NSP) such as β -Glucan that varies seasonally in malt.

Proteases: Increase extract when using poorly modified malt or unmalted adjuncts.

MATERIAL EFFICIENCY: MALT

INACTIVATED SPECIFIC YEAST (ISY)



What is Inactivated Specific Yeast (ISY) ?

A yeast derivative that is used for purposes other than nutrition

ISY Enhance:

- Rich in mannoproteins.
- Increases body and mouthfeel
- Reduces hop burn
- Improves overall balance
- **Substitution of some malt for adjuncts**
- **More economical and easier to use than maltodextrin**

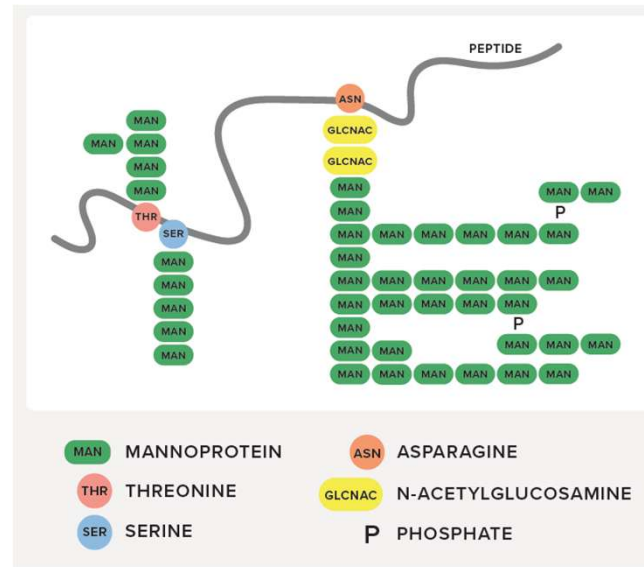
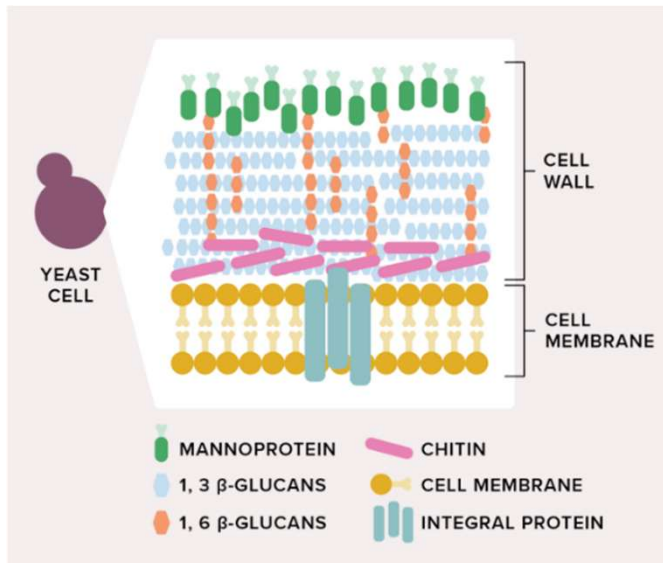


MATERIAL EFFICIENCY: MALT INACTIVATED SPECIFIC YEAST (ISY)



ISY Enhance – More than just a generic “yeast extract”

- A specific yeast strain
- Specialized mannoprotein extraction process

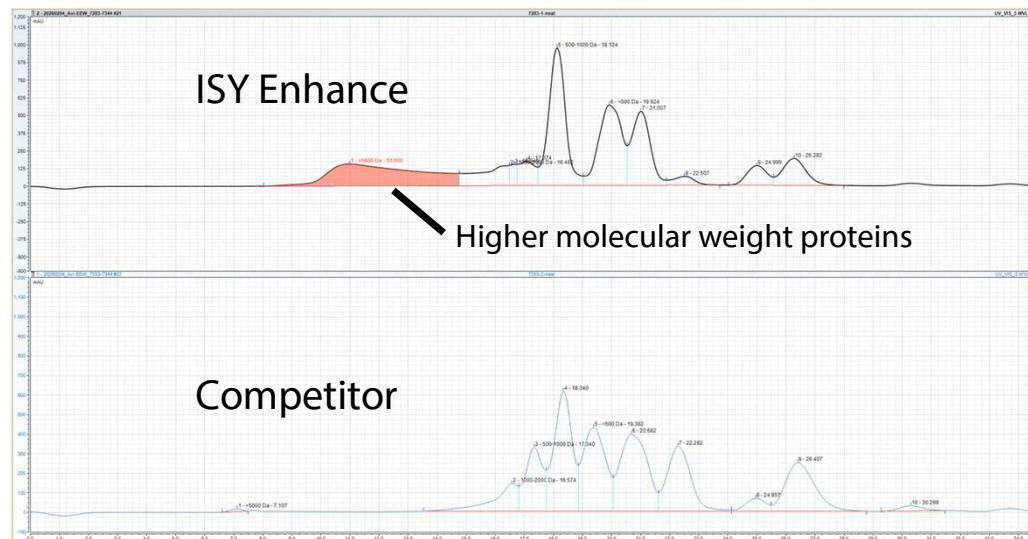


MATERIAL EFFICIENCY: MALT INACTIVATED SPECIFIC YEAST (ISY)



ISY Enhance

Sample	%Solubility
ISY Enhance	74%
Competitor	56%



- Greater solubility = more efficient
- = more dissolved solids per gram of product
- Higher MW proteins = Greater texture and palette weight










MATERIAL EFFICIENCY: MALT INACTIVATED SPECIFIC YEAST (ISY)



ISY Enhance

RECOMMENDED DOSE RATES BY BEER STYLES

100ml beer							
10% ISY Enhance™ solution		0.1 ml	0.2 ml	0.3 ml	0.4 ml	0.5 ml	0.6 ml
Equivalent dosage	Control	10 g/hl	20 g/hl	30 g/hl	40 g/hl	50 g/hl	60 g/hl
Beer styles		No / Low Alcohol		Table beer 2-3%		IPA	
					Porter / Stout		



MATERIAL EFFICIENCY: HOPS

Yeast Strain

Biotransformation Optimization

Flavor Additions

Enzymes

Process Aids



YEAST STRAINS

MATERIAL EFFICIENCY: HOPS



Hop Aroma: Terpenes and Thiols
Yeast Aroma: Esters and Fusels

Synergy: Yeast aroma expression can **indirectly** enhance hop aroma
Biotransformation: Yeast can interact **directly** with hop aroma compounds and precursors to increase and enhance total hop aroma



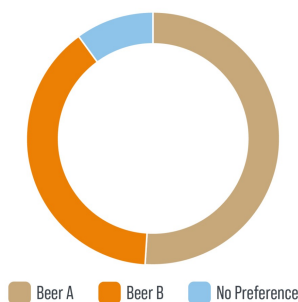
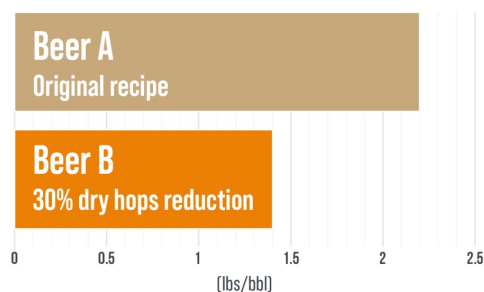
YEAST STRAINS

MATERIAL EFFICIENCY: HOPS



Case study with Lake Time Brewing (USA)

Dry hop reduced 30% while fermenting with LalBrew Pomona™



*“We originally gave LalBrew Pomona™ a try because we’d worked with several similar yeast strains before, but none really hit the mark for us. Once we switched, the difference was clear — **the hop expression was noticeably better than anything we’d used previously.** It brought out the character we’d been chasing. So, we wondered if we could reduce our dry hop rates as a result.”* Aaron DePue, Brewer at Lake Time

[Biotransformative yeast: A case study in production efficiency - Lallemand Brewing](#)

BIOTRANSFORMATION OPTIMIZATION

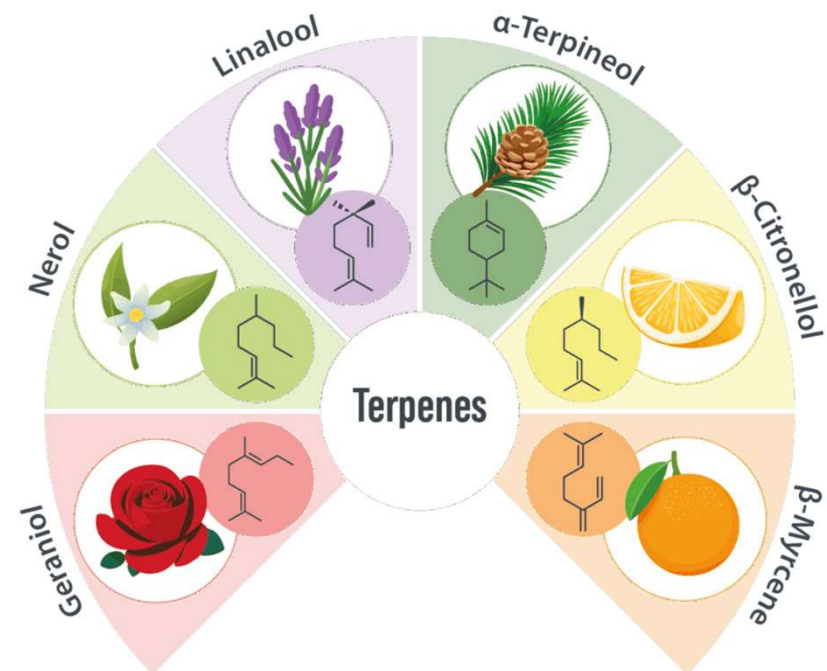
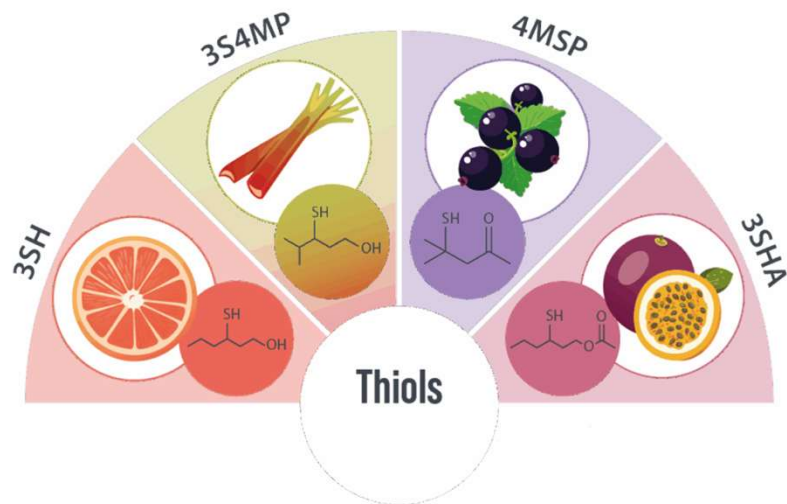
MATERIAL EFFICIENCY: HOPS



Hops oils contain aromatic terpenes and thiol compounds.

Can exist as a free aromatic form (unbound), or as a non-aromatic precursor (bound to another molecule).

Yeast can increase hop aroma by releasing non-aromatic precursors to their free aromatic form.



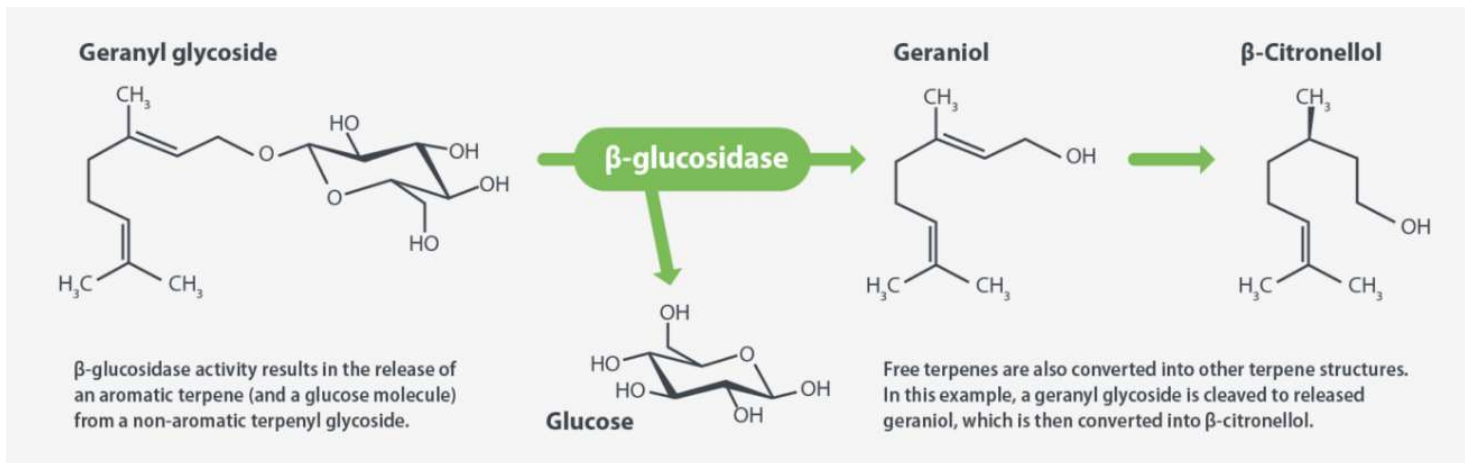
MATERIAL EFFICIENCY: HOPS

BIOTRANSFORMATION OPTIMIZATION



Enzymes can be added to boost biotransformation and enhance hop aroma.

Aromazyme is a beta-glucosidase enzyme that increase the release of aromatic terpenes from glycoside precursors.



MATERIAL EFFICIENCY: HOPS

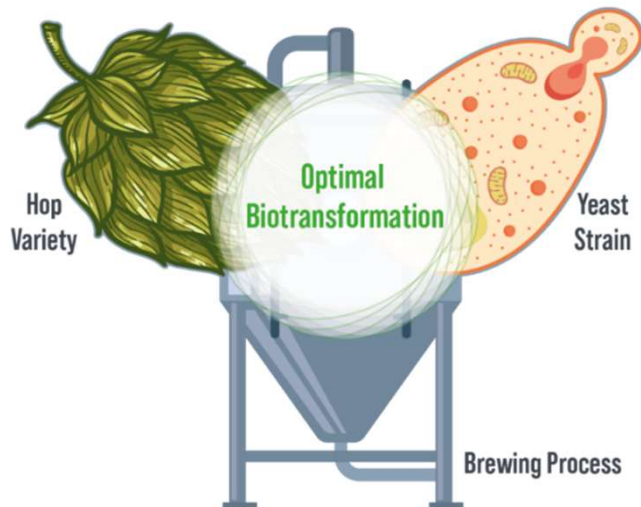
BIOTRANSFORMATION OPTIMIZATION



LALLEMAND

BrewEd | KNOWLEDGE CENTER

BIOTRANSFORMATION



Siebel Institute
OF TECHNOLOGY



**New Biotransformation
sensory kit coming soon!**

<https://www.lallemantbrewing.com/en/biotransformation-resources-center/>

FLAVOR ADDITIONS

MATERIAL EFFICIENCY: HOPS



Flavor additions can include **hop derivatives**, or **pure flavor compounds**.

Yops™ are blends of aroma compounds produced by precision fermentation.



YOPS® CASE STUDIES

MATERIAL EFFICIENCY: HOPS



Brew Dog *UK)

West Coast IPA – 6% ABV

Reduced dry hopping by 50%

"Using Yops® was brilliant from the start. It's just like using terpene or flavor extracts. No extra hassle, just dose in the tank and Yops® speaks for itself."

— AJ ROBIESON, OUTPOST BREWER, BREWD OG WATERLOO.



Vertiga (Italy)

Session IPA – 4.1% ABV

Complete replacement of dry hops with Yops®

"By using Yops® we were able to increase our production by 7% compared to dry-hopping, achieving a more explosive and defined sensory profile, with the citric and floral markers clearly evident but at the same time well-blended with the beer."

— CLAUDIO TURCATO, HEAD BREWER AT VERTIGA.

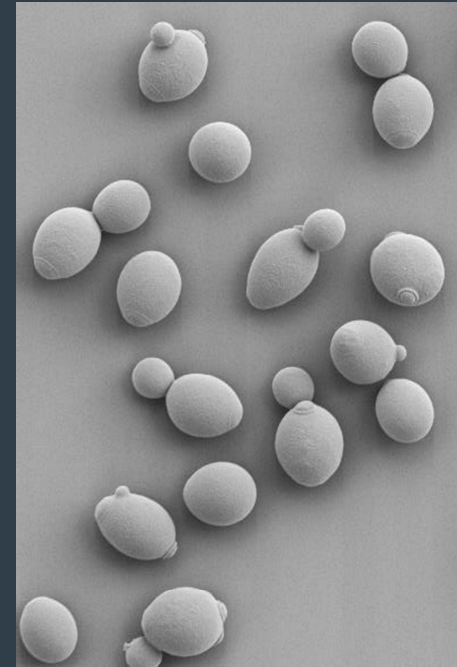
MATERIAL EFFICIENCY: YEAST

Yeast Strain

Nutrients

Repitching

Fermentation Conditions



YEAST STRAIN

MATERIAL EFFICIENCY: YEAST



LalBrew House Ale™

Trial feedback shows up to **50% reduced pitch rate** compared to reference strain (usually Chico)



LalBrew NovaLager™

Novel hybrid *S. pastorianus* (true lager strain)
More tolerant of warmer fermentations
= **lower pitch rates**



LalBrew Voss™

Very fast fermentations
Supports low pitch rates while maintaining fast fermentations when fermented warm (30-40°C)

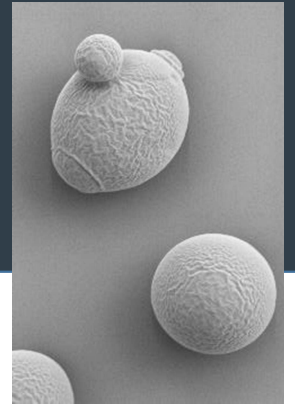


LalBrew Nottingham™

The original High Performance Ale Yeast
Fast, stress tolerant, low pitch rates

LALBREW HOUSE ALE™

MATERIAL EFFICIENCY: YEAST



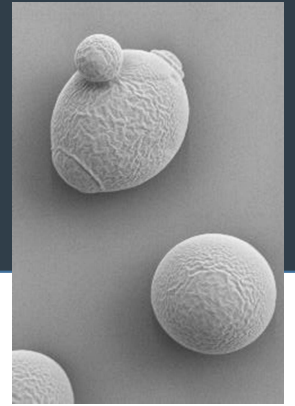
Clear and consistent preference over other house strains

- + Lower pitch rates (up to 50% in trials)
- + Faster fermentations (up to 23% in trials)
- + Shorter maturations
- + Faster tank turnaround
- + Versatile for many beer styles
- + Excellent repitchability
- + Easy clarification
- + Stress-tolerant

= A New Standard in Yeast Performance

YEAST STRAIN

MATERIAL EFFICIENCY: YEAST



WildBrew Philly Sour™ is a unique species of *Lachancea thermotolerans* that produces low to medium amounts of lactic acid during alcoholic fermentation.



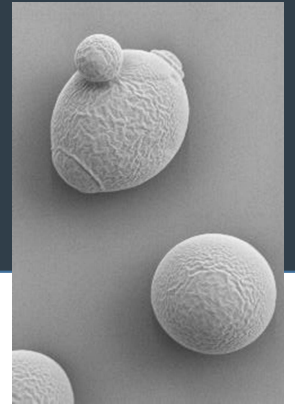
Sourvisiae® is a GMO strain of *S.cerevisiae* that was bioengineered to produce high levels of lactic acid during alcoholic fermentation.

Advantages of Lactic Acid Yeast:

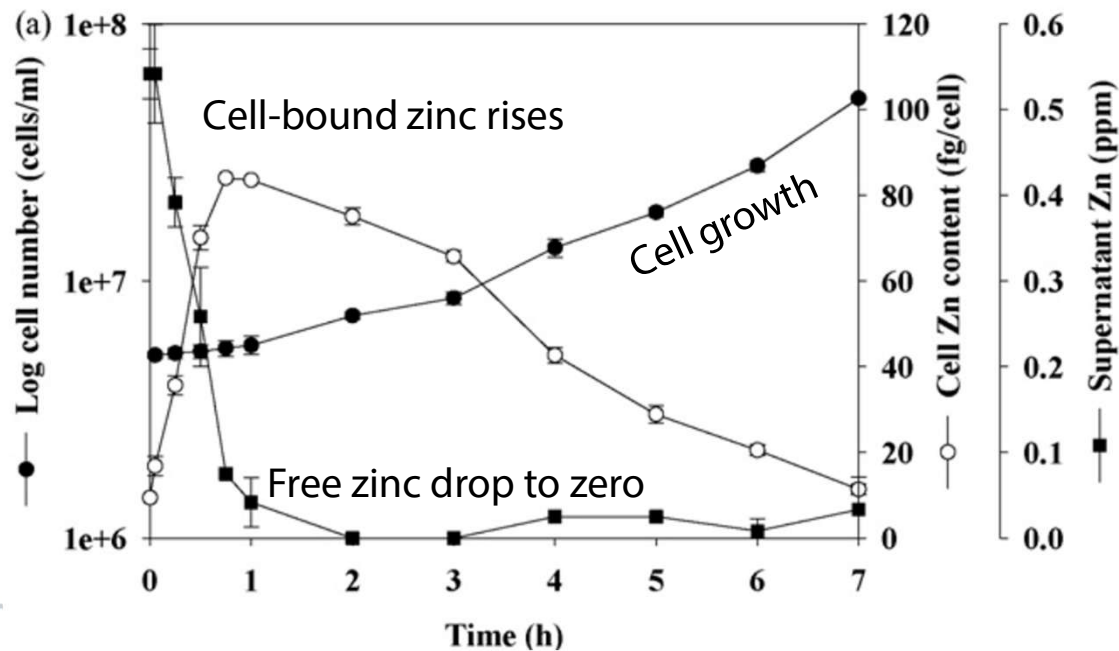
- No need to perform a kettle sour
- No need to purchase bacteria

NUTRIENTS & REPITCHING

MATERIAL EFFICIENCY: YEAST

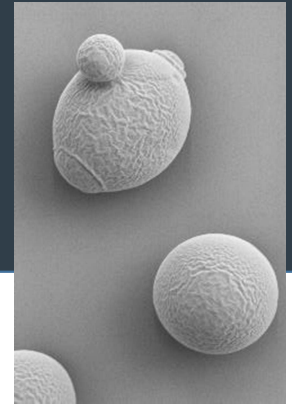


Most all-grain worts have sufficient nitrogen, but lack zinc.
Zinc is taken up by yeast cells within first few hours of fermentation.



NUTRIENTS & REPITCHING

MATERIAL EFFICIENCY: YEAST



All-Malt Wort

Gen 1 – little difference

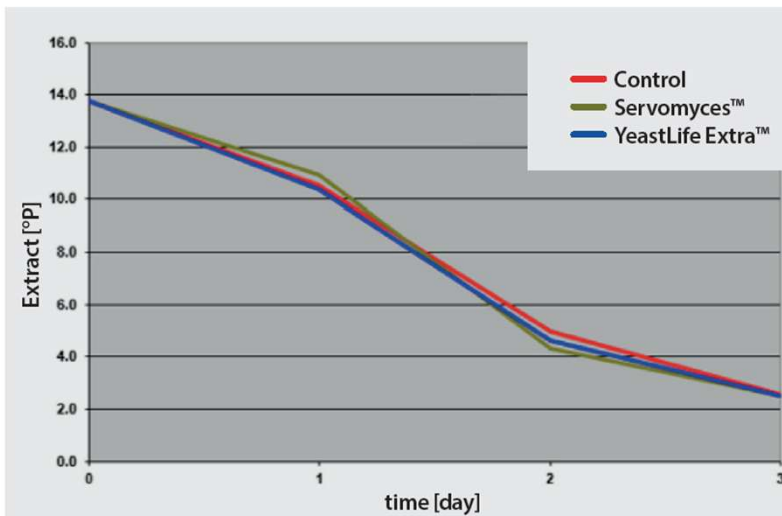


Figure 1: All-malt wort - Generation 1

Gen 8 – faster fermentations with zinc enrichment

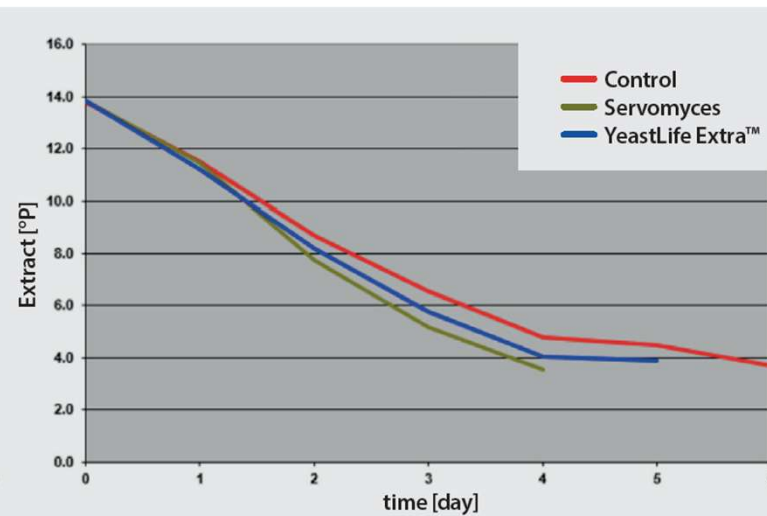
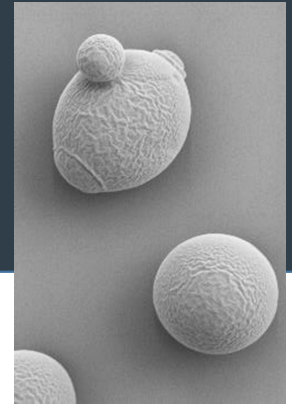


Figure 2: All-malt wort - Generation 8



NUTRIENTS & REPITCHING

MATERIAL EFFICIENCY: YEAST



High Gravity, Adjunct Wort

Gen 1 & Gen 8 both see faster fermentations with zinc supplementation

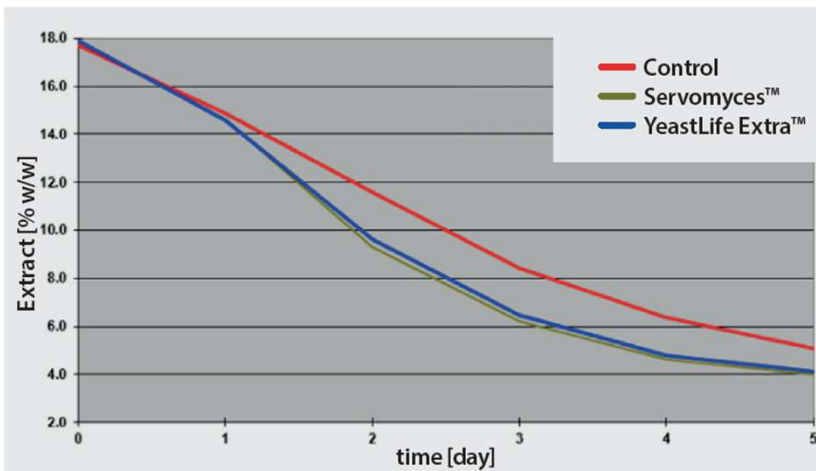


Figure 3: High gravity, high adjunct wort - Generation 1

Contains 60% malt extract 40% high maltose corn syrup

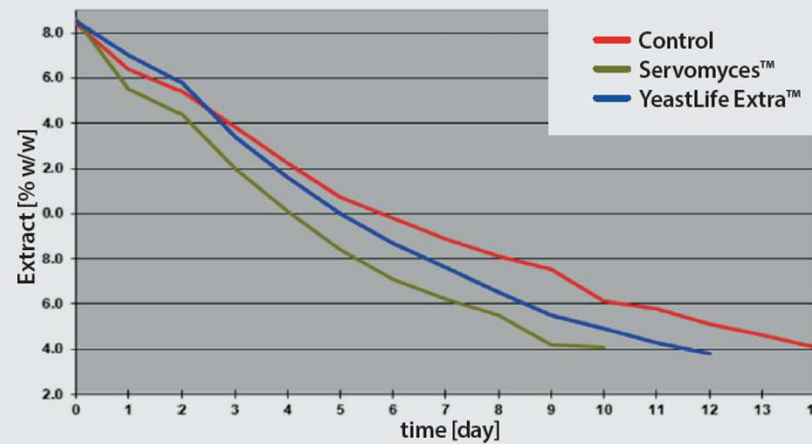


Figure 4: High gravity, high adjunct wort - Generation 8



MATERIAL EFFICIENCY: YEAST

FERMENTATION CONDITIONS



Aussie Fast Lager Method:

- Method developed by Lallemand Brewing team in Australia/NZ
- Use Servomyces and warm initial temperature to act as a short propagation step.

Benefits:

- Reduced production time
- Lower pitch rate & cost
- Clean and crisp lager flavor



MATERIAL EFFICIENCY: YEAST

FERMENTATION CONDITIONS



Traditional Profile:

LalBrew Diamond™ 130g/hL

Servomyces™ 1g/hL

12°C fermentation until terminal gravity

17°C diacetyl rest (24hrs)

Total fermentation time: 7-10 days

Aussie Fast Lager Profile:

LalBrew Diamond™ 130g/hL

Servomyces™ 1g/hL

17°C fermentation until onset of active fermentation

Cool to 12°C and hold 24hrs

Free rise temp to 17 °C until terminal gravity

17°C diacetyl rest (24hrs)

Total fermentation time: 5-6 days

MATERIAL EFFICIENCY: REDUCING LOSSES & WASTAGE

Process Aids

Enzymes

Antioxidants

Flavor Additions



MATERIAL EFFICIENCY: REDUCING LOSSES & WASTAGE

FLAVOR PRODUCTS

Loss of ~15L of beer per kg of dry hop

Replacing some dry hops with flavor products like Yops™ or hop derivatives can reduce losses and boost yields.

Dry hop rate: 1kg/hL

Substitution: 15L beer saved

Yield boosted 15%



Yops Calculator for Cost Savings

TIME EFFICIENCY

Mash & Lauter

Fermentation and Maturation

Filtration



FERMENTATION

TIME EFFICIENCY



Yeast Strain:



Fast and Efficient



Avoid Kettle Sour



Avoid Alcohol Removal

Fermentation Conditions:

Aussie Fast Lager Method



Nutrients:

- Faster fermentation increases tank turnaround
- Fewer off flavors (i.e. H₂S, diacetyl) to be reabsorbed by yeast

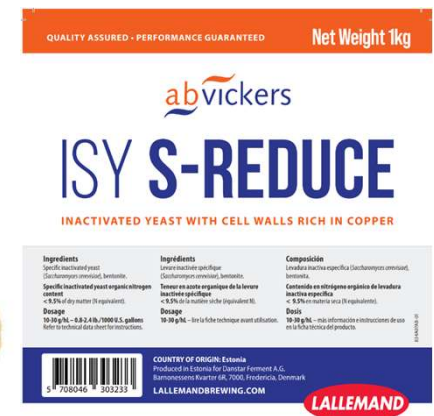
MATURATION

TIME EFFICIENCY



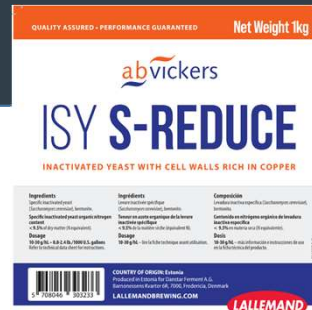
- Proteases:** - Proline-specific protease reduces chill haze (shorter maturation)
- ALDC:** - Prevents formation of diacetyl, no need to diacetyl rest
- Finings:** - Faster clarification, shorter maturation, increased tank utilisation

- ISY S-Reduce:** - Removes H₂S and other sulfur compounds
- Corrective action

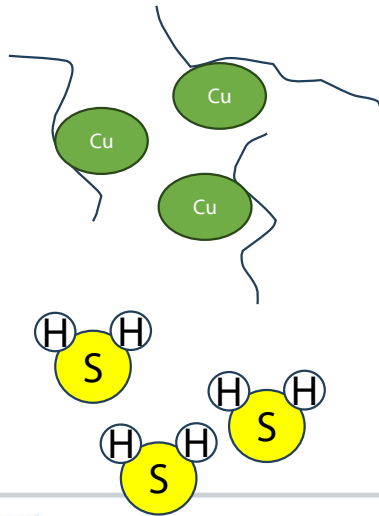


MATURATION

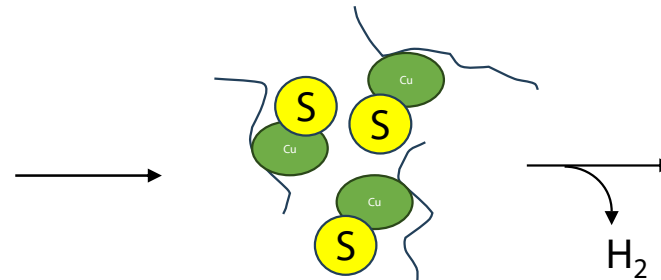
TIME EFFICIENCY



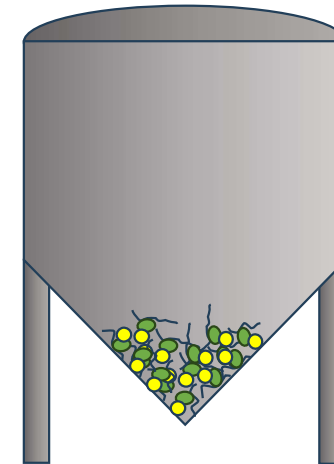
Beer containing H_2S is treated with copper bound to yeast cell walls



Copper binds to sulfur to form insoluble copper sulfide (CuS)



CuS -cell walls settle out of the beer or are removed by fining, centrifuge, or filtration.



MATURATION

TIME EFFICIENCY

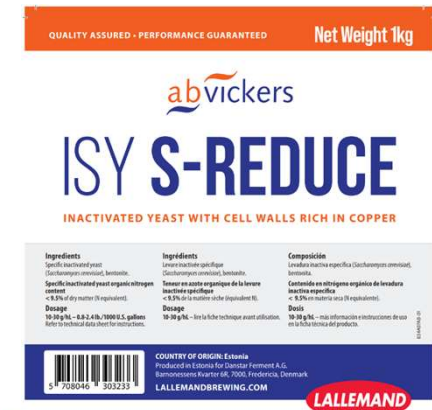


ISY S-Reduce:

- Yeast-derived product
- Biologically bound copper – Less copper in final product

Benefits:

- Removes H₂S efficiently
- May remove other sulfur off-flavors (i.e. DMS, diethyl sulfide, mercaptan)
- No copper carry-over = No increased oxidation risk
- Increases perception of fruity aromas
- **Avoid extended maturation**



ENVIRONMENTAL EFFICIENCY

Energy

Water

CO₂ and Natural Resources

Reducing Waste

Greenwashing

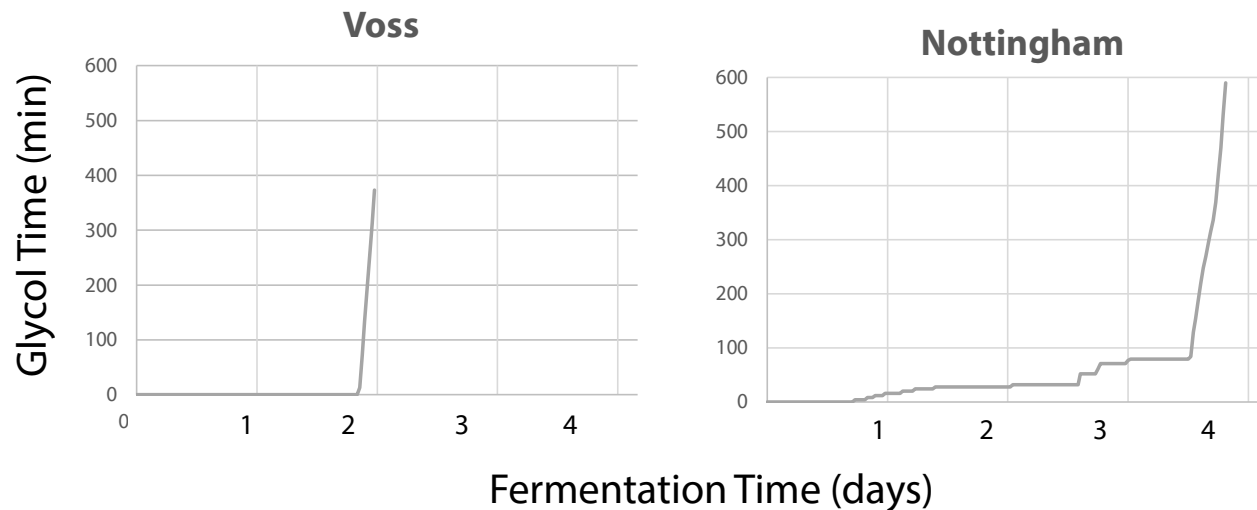


ENERGY

ENVIRONMENTAL EFFICIENCY



- Energy required for temperature control during fermentation and maturation.
- Cooling during maturation is more significant than during fermentation.
- Energy savings by warm fermentation yeast are equivalent to only about 12 hours of glycol use.



Greenwashing:
Be skeptical of promises for energy savings !

If you don't reduce your maturation time, energy savings are minimal.

ENERGY

ENVIRONMENTAL EFFICIENCY



Yeast Impact on Maturation Time:

MET10 technology has been incorporated into hybrid yeast strains (non-GMO)

These strains will not produce H₂S = shorter maturation period

LalBrew® PREMIUM SERIES LALLEMAND

NOVALAGER

MODERN HYBRID LAGER YEAST

Saccharomyces pastorianus

LalBrew® PREMIUM SERIES LALLEMAND

FARMHOUSE

HYBRID SAISON-STYLE YEAST

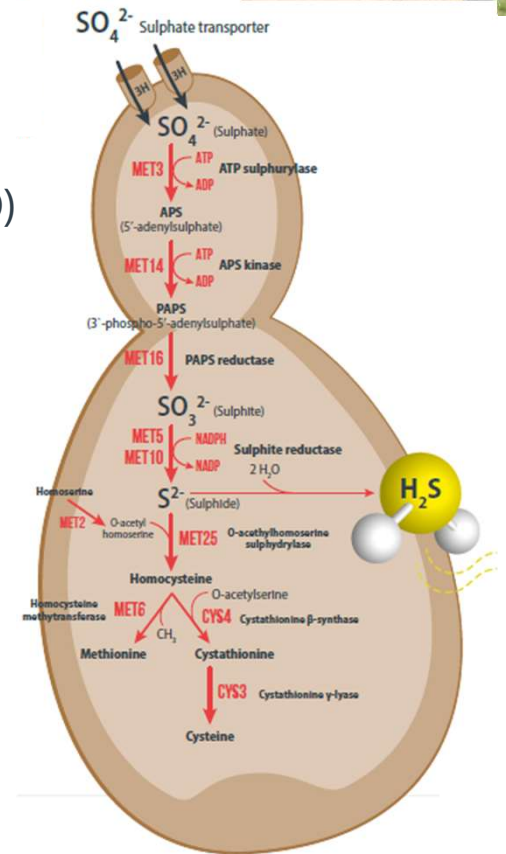
Saccharomyces cerevisiae

LalBrew® PREMIUM SERIES LALLEMAND

LONA

LOW ALCOHOL HYBRID ALE YEAST

Saccharomyces cerevisiae




ENVIRONMENTAL EFFICIENCY

CO2 AND NATURAL RESOURCES




Yops™ is more environmentally friendly

 **83%**
less CO2 emissions

 **84%**
less energy used

 **86%**
less water use

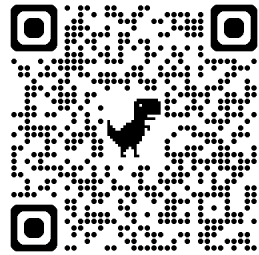
 **94%**
less land use

vs. traditional aroma hops

Source: Comparative Life Cycle Assessment on Yops™, prepared for EvodiaBio ApS by the Danish Technological Institute, Feb 2024

Yops™ Savings Calculator

Find out the impact of using Yops in your specific recipe.



<https://evodiabio.com/yops-calculator/>

Greenwashing:

Many sustainability claims are misleading, incomplete, or simply false!

Look for claims backed by data, ideally a full LCA

BREWER'S TOOLKIT: YEAST & FERMENTATION

Lower pitch rate



LalBrew
NovaLager™



LalBrew
Voss™



LalBrew
NovaLager™



LalBrew
Nottingham™

Lower hop rate /
Less expensive hops



LalBrew
Verdant IPA™



LalBrew
New England™



LalBrew
Pomona™



AB Vickers®
Aromazyme™



Yops™

Shorter maturation



LalBrew
Farmhouse™



LalBrew
NovaLager™

Avoid alcohol removal
equipment / Process



LalBrew®
LoNa™

Faster fermentations



LalBrew
Voss™



LalBrew
Nottingham™



LalBrew
NovaLager™



LalBrew
House Ale™



YEASTLIFE^{EXTRA}
YEASTLIFE 0™

Avoid Kettle Souring



WildBrew
Philly Sour™



Mascoma
Sourvisiae™

Reduced cooling
requirements



LalBrew
Voss™



LalBrew
NovaLager™

Repitching yeast

LalBrew®
PREMIUM SERIES

YEASTLIFE^{EXTRA}



Servomyces®



BEST PRACTICE SUMMARY

BEST PRACTICES

BIOTRANSFORMATION & IPA SOLUTIONS



India Pale Ale (IPA) is a beer style defined by higher hopping rates. In the late 18th century, British brewers would preserve beer for export by using higher levels of alcohol and hops, thus introducing a recipe that became popular in British colonized India. The modern IPA family includes a diverse range of beer styles that are all defined by their very prominent hoppy character.

The choice of yeast strain is an important consideration in brewing any IPA style. Each yeast strain produces unique flavor compounds that directly impact the aroma of the final beer, from relatively neutral to more fruity esters. The level of attenuation will impact the body and perception of bitterness, and the genetics and metabolism of the yeast will impact the clarity of the finished beer.

Brewing labs are discovering how different yeast strains can influence flavor and aroma by interacting with specific hop-derived flavor compounds, a process collectively known as biotransformation. Yeasts produce enzymes that interact with hops to release or modify aromatic terpenes (citrus, floral) and thiols (tropical) to enhance the overall hop sensory profile. The combination of primary yeast metabolism (attenuation, production of esters, flocculation) and secondary interactions with hop compounds (biotransformation) will determine the flavor and aroma of the finished beer.

LALBREW STRAINS BY BEER STYLE	BIY-37	LOMA™	NEW ENGLAND	NOTT/INDIAN	NOTT/LAGER	PURINA	VERMONT IPA	WISCONSIN	WISS
BLACK IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
BRUT IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
COLD IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
DOUBLE IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISH IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
NEW ENGLAND IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
NON-ALCOHOL IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
SESSION IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
SOUR IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓
WEST COAST IPA	✓	✓	✓	✓	✓	✓	✓	✓	✓

Lallemand Brewing's yeast strains, combined with our brewing expertise, empower brewers to achieve the desired hop-forward flavors for any IPA style.

Throughout this document, we provide detailed information about LalBrew Premium® yeast strains, including the biotransformation potential of terpene and thiol compounds. We also discuss general strategies for optimizing the brewing process to maximize specific hop aromas. Armed with this data, the brewer is well equipped to choose the best yeast for each IPA style.

Lallemand Brewing is at the forefront of hop flavor and aroma research, and we are ready to help you with any questions about brewing hoppy beer styles.

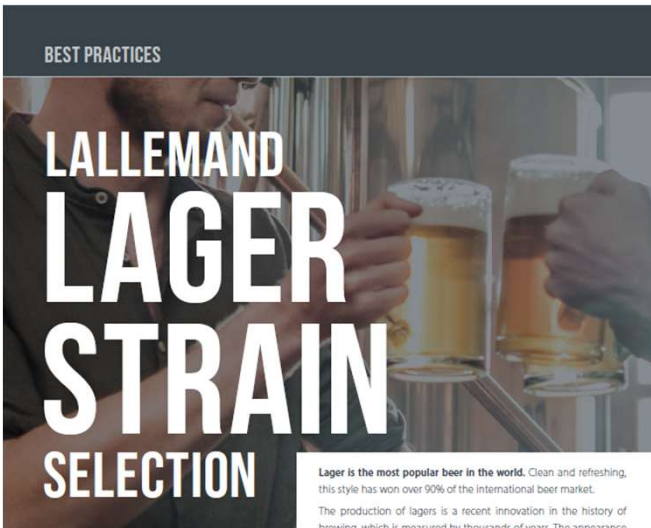
For more information, you can reach us via email at brewing@lallemand.com

www.lallemandbrewing.com



BEST PRACTICES

LALLEMAND LAGER STRAIN SELECTION



Lager is the most popular beer in the world. Clean and refreshing, this style has won over 90% of the international beer market.

The production of lagers is a recent innovation in the history of brewing, which is measured by thousands of years. The appearance of lagers is attributed to the XV-XVI centuries, and Bavaria is considered the birthplace of the style.



FIG. 1: Galls growing on a southern beech tree in Patagonia.

The key feature of the lager style is using the authentic type of yeast called *Saccharomyces pastorianus*. In the 1980s, while studying the DNA of the lager yeast, researchers discovered that it was a hybrid of the ale yeast *Saccharomyces cerevisiae* and a hitherto unknown microorganism. But in 2007 microbiologists found that the genes of that microorganism are 99.5% identical to a yeast found in Patagonia, which the local population used to produce alcohol at low temperatures. Yeast was contained in "galls", spherical growths on southern beech trees, inside of which juice is fermented (Figure 1). This strain was named *Saccharomyces eubayanus*.

For more information, you can reach us via email at brewing@lallemand.com

www.lallemandbrewing.com



BEST PRACTICES

NABLAB NON-ALCOHOL BEER & LOW ALCOHOL BEER

A Novel Fermentation Approach to NABLAB

Non-alcohol beers and low alcohol beers (NABLAB) have been brewed throughout history for a variety of reasons including, the scarcity of raw materials, moral or religious abstinence, conformity with local laws, and personal health and well-being. Craft brewers have historically focused on stronger, higher ABV beer styles while lower alcohol styles have largely been ignored. As a result, commercial NABLAB were often dull and lacking in flavor, or presenting specific flavors that made it difficult to match the sensory profile of traditional beer styles. As demand for NABLAB grows, craft brewers are now brewing a wider variety of great tasting NABLAB styles than ever before. There are different approaches to producing NABLAB, each of which requires substantial process and recipe optimization. In this document, we provide an overview of current best practices for crafting high quality NABLAB using a limited fermentation approach.

In general, non-alcohol beers are defined as < 0.5% ABV and low alcohol beers are in the range of 0.5 - 1.5% ABV. These definitions may vary by region.

Alcohol Removal – Difficult, Costly and Diminished Flavor

A common method for producing NABLAB is to remove the ethanol from a standard beer. This can be done using either a heating and distillation approach, or through reverse osmosis.

Pros:

- Scalable to large production volumes
- Able to achieve 0.0% ABV (distillation)
- Better suited for large industrial breweries

Cons:

- Expensive equipment
- Energy intensive
- Significant process optimization
- Positive flavors are stripped along with alcohol
- Permits required for distillation
- Higher risk of oxidation
- Flavor matching can be difficult due to flavor losses

Limited Fermentation – Simple and Cost Effective

Lower alcohol levels can be achieved by reducing the amount of sugar consumed during fermentation. There are two main ways of limiting fermentation in this way:

- 1. Arrested fermentation:** Yeast metabolism is stopped after only a small amount of wort sugar is consumed, leaving fermentable sugars remaining in the beer. This is accomplished by adding yeast to already cold wort (cold contact), rapid cooling, or pasteurization. These methods require close analytical control and can have poor flavor outcomes.
- 2. Limited wort fermentability:** The quantity of fermentable sugar in the starting wort is reduced by using a modified grain bill, shortening the mash time, or mashing at high temperatures to decrease the amount of glucose and maltose, while increasing the proportion of higher molecule weight sugars. Selecting a limited fermentation yeast strain incapable of fermenting maltotriose or maltose will allow for lower attenuation. A combination of these methods can be employed to achieve lower wort fermentability. Since some simple sugars are left unfermented, pasteurization is required to stabilize the product and prevent fermentation after packaging by contaminating microorganisms.

Arrested fermentation		Limited Wort Fermentability	
Pits	Cons	Pits	Cons
Allows for use of traditional brewing equipment	Worty flavors, diacetyl, and H ₂ S are common.	Allows for use of traditional brewing equipment.	Recipe must be optimized to achieve desired flavors.
	Close analytical control required to ensure precise process timing.	Fermentation proceeds to full attenuation.	Very high mashing temperatures are required to achieve <0.5% ABV using maltotriose-negative strains.
	High risk of overattenuation.	Low risk of overattenuation	Wild maltose-negative yeast do not produce typical beer fermentation performance and flavor.
	Lack of consistency	Greater consistency batch to batch	

TABLE 1: Comparison of different methods of limited fermentation.

For more information, you can reach us via email at brewing@lallemand.com

www.lallemandbrewing.com





THANK YOU

WE BREW WITH YOU™

Questions – » brewing@lallemand.com



LALLEMAND BREWING

**WE BREW
WITH YOU.™**



WE BREW WITH YOU®

