LALLEMAND

PROCESS OPTIMIZATION AND SUSTAINABILITY

- TECHNOLOGICAL AND BIOTECHNOLOGICAL SOLUTIONS -

WE BREW WITH YOU®

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Gianmaria Ricciardi

- **Lallemand Brewing**
  - Technical Sales Manager
- **Working in the brewing industry since 2009**
  - Brewer (Italy and the UK)
- **Graduated in Food Technology and Biotechnology**
  - C.E.R.B. (Italian Brewing Research Centre)

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AGENDA

- PROCESS OPTIMIZATION WITH LALBREW® PREMIUM SERIES AND WILDBREW® BIOTECHNOLOGY SOLUTIONS
- LEVERAGING ENZYMES AND PROCESSING AIDS TO IMPROVE PROCESS EFFICIENCY – AB VICKERS
- PROCESS SUSTAINABILITY WITH SIEBEL INSTITUTE OF TECHNOLOGY FORMATION

LALLEMAND BREWING BUSINESS UNIT

LALLEMAND BREWING LALLEMAND abvickers 1872 Siebel Institute OF TECHNOLOGY

Our team prides itself on offering much more than just products and services.

QUALITY

Repitching, reliability and safety

- **24 control points**
- **100 years** of experience in fermentations
- Produced in **Europe**

To learn more

INNOVATION & PASSION

R&D collaborations with the academic community and the brewing industry all over the world.

- **The first dry bacteria** product specifically for beer brewing applications
- **The first bioengineered commercial dry yeast** for beer brewing applications*
- **The first dry Kveik strain for commercial use**
- **The first dry non-Saccharomyces species** for beer brewing applications

*available in the US only

To learn more

TECHNICAL SUPPORT

We Brew With You™

- **Knowledge:** most of our brewing team worked as brewers in the past.
- **Availability:** always ready to support you thanks our international technical team.
- **Easy to reach:** email, phone/mobile, website, mobile app, social media...we are here for you!

Meet our team

PROCESS OPTIMIZATION WITH LALBREW® PREMIUM SERIES AND WILDBREW® BIOTECHNOLOGY SOLUTIONS

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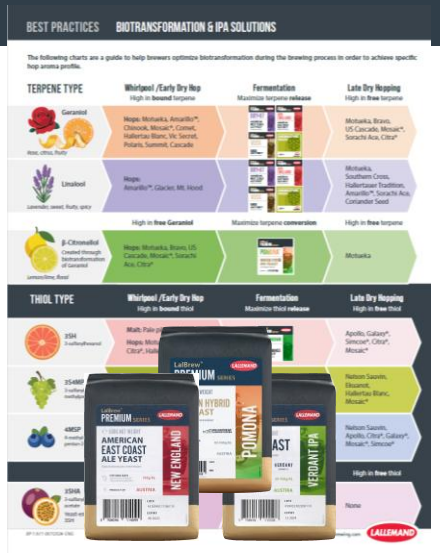
LALBREW® PREMIUM



- LalBrew New England™, LalBrew Verdant IPA™ & LalBrew Pomona™
  - Aromatic strains, with a high capacity to free aromatic compounds from their odourless precursors (hops and other raw materials)
- LalBrew Voss™ & LalBrew NovaLager™
  - Strains extremely thermotolerant and performing; neutral flavour profiles and high versatility
- LalBrew Farmhouse™
  - Diastaticus negative
- LalBrew Nottingham™
  - Backup yeast; high affinity to maltotriose

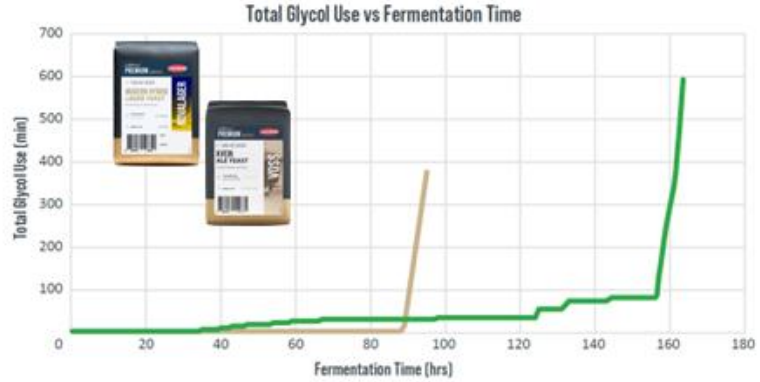
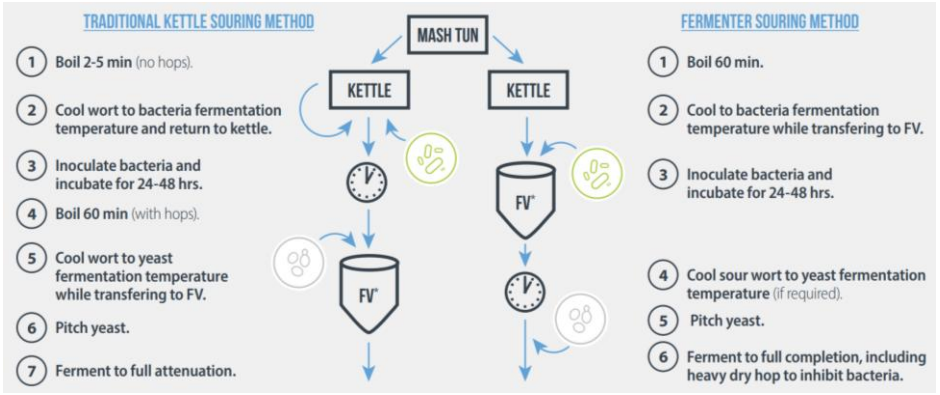
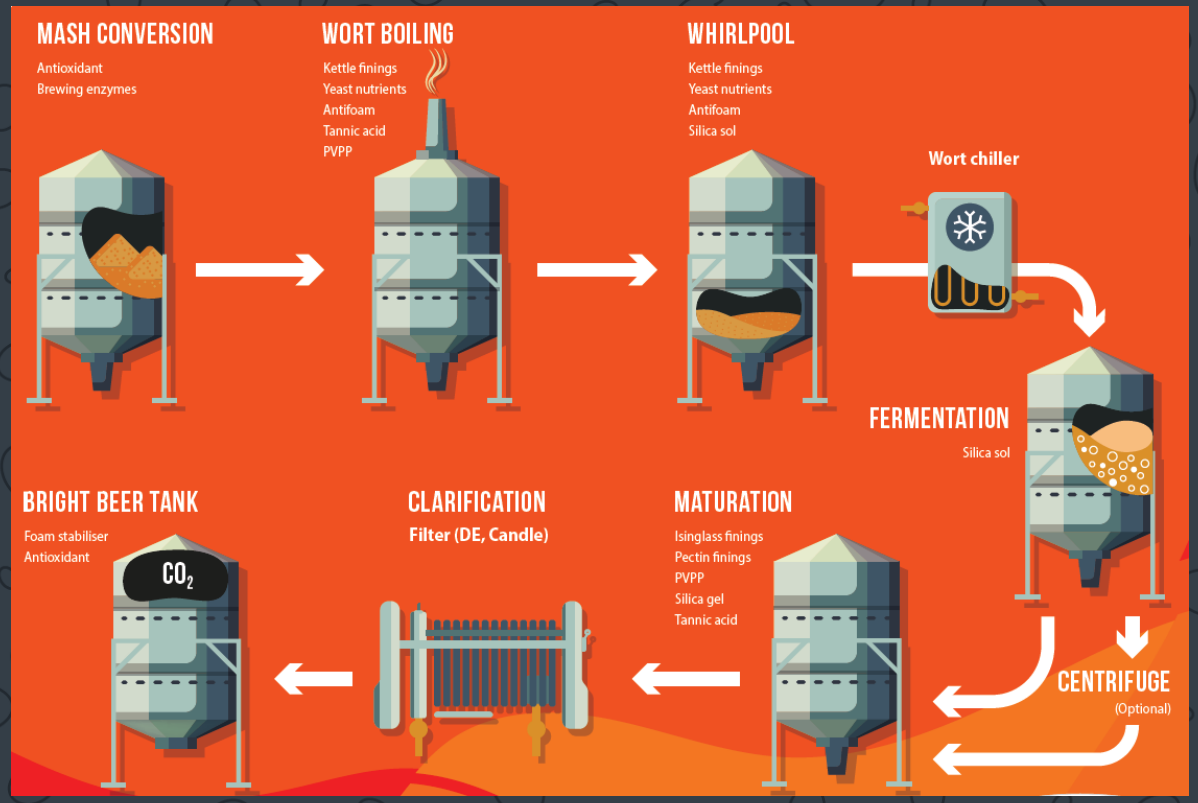


Fig. 1: Total fermenter glycol chilling time when using LalBrew Voss™ and LalBrew Nottingham™

WILDBREW®

- WildBrew Philly Sour™
  - Innovative non-saccharomyces strain (Lachancea spp.) – lactic acid yeast
- WildBrew Sour Pitch™ & WildBrew Helveticus Pitch™
  - Fermenter Souring





LEVERAGING ENZYMES AND PROCESSING AIDS TO IMPROVE PROCESS EFFICIENCY – AB VICKERS

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PERFORMANCE GUARANTEED

Summary of Benefits of Enzymes, Process Aids & Nutrients

abvickers	Shorter Maturation	Shorter Fermentation	Greater Extract	Facilitates Sustainable Ingredients (local, organic, adjuncts)	Great Product Stability / Longer Shelf Life	Reduced Wastage (product, packaging)	Increased Yield / Reduced Losses	Use Less Raw Material (malt, hops, yeast)	Use Less Consumables (chemicals, filter material)	Use Less Water
BALANCED NUTRIENTS • Yeastlife Extra™ • Yeastlife O™	✔	✔		✔						
ZINC NUTRIENT • Servomyces™								✔		
GLUCOSIDIC ENZYMES • Alphamylase™ • Glucoamylase™			✔	✔						
GLUCANASE™			✔	✔						
NEUTRAL PROTEASE • Protozyme™			✔	✔						
PROLINE-SPECIFIC PROTEASE • Clarizyme™	✔				✔	✔				
ANTIOXIDANT • Vicant™					✔	✔				
ACETOLACTATE DECARBOXYLASE • ALDC™	✔									
FININGS • Compac CG™	✔						✔		✔	✔
ANTIFOAM • Foamsol™							✔	✔	✔	✔
β-GLUCOSIDASE • Aromazyme™								✔		

ISINGLASS FININGS	CRYO**FINE**
VEGAN FININGS	PROTO**SOL** PROTO**FINE**
KETTLE FININGS	**COMPAC** CG TABLET **COMPAC** CG
ANTIFOAM	FOAM**SOL**
YEAST NUTRIENTS	YEAST**LIFE** *EXTRA* YEAST**LIFE O**™
BEER STABILISERS	ALPHA**CLAR** S
ENZYMES	GLUCO**AMYLASE** 400 **GLUCANASE** PREMIER ALPHA ACETOLACTATE **ALDC** DECARBOXYLASE CLARI**ZYME** AROMAZYME
ANTIOXIDANTS	**VICANT** SBX **VICANT** SB

RESOURCES

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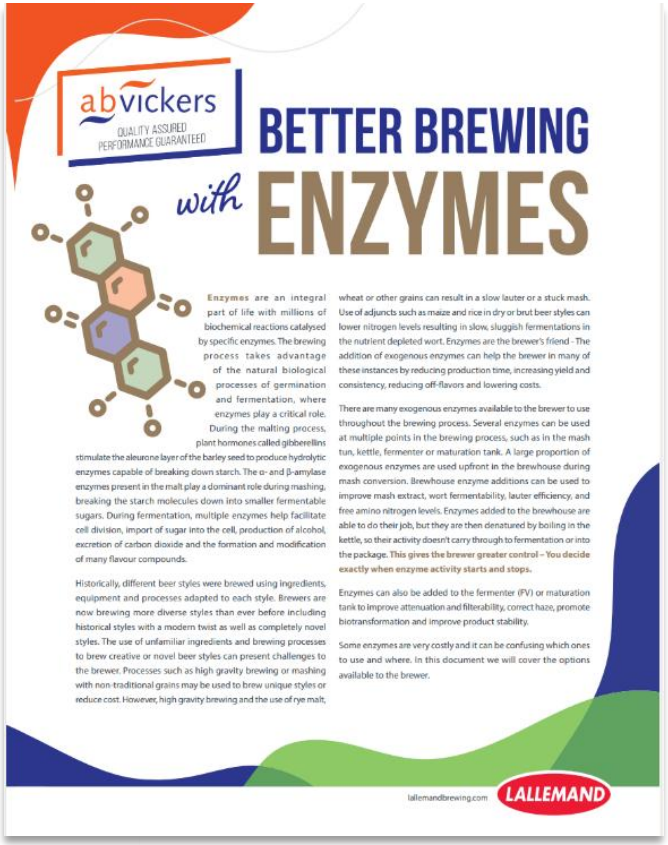

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BETTER BREWING *with* ENZYMES

Enzymes are an integral part of life with millions of biochemical reactions catalysed by specific enzymes. The brewing process takes advantage of the natural biological processes of germination and fermentation, where enzymes play a critical role. During the malting process, plant hormones called gibberellins stimulate the aleurone layer of the barley seed to produce hydrolytic enzymes capable of breaking down starch. The α- and β-amylase enzymes present in the malt play a dominant role during mashing, breaking the starch molecules down into smaller fermentable sugars. During fermentation, multiple enzymes help facilitate cell division, import of sugar into the cell, production of alcohol, excretion of carbon dioxide and the formation and modification of many flavour compounds.

Historically, different beer styles were brewed using ingredients, equipment and processes adapted to each style. Brewers are now brewing more diverse styles than ever before including historical styles with a modern twist as well as completely novel styles. The use of unfamiliar ingredients and brewing processes to brew creative or novel beer styles can present challenges to the brewer. Processes such as high gravity brewing or mashing with non-traditional grains may be used to brew unique styles or reduce cost. However, high gravity brewing and the use of rye malt, wheat or other grains can result in a slow lauter or a stuck mash. Use of adjuncts such as maize and rice in dry or brut beer styles can lower nitrogen levels resulting in slow, sluggish fermentations in the nutrient depleted wort. Enzymes are the brewer's friend - The addition of exogenous enzymes can help the brewer in many of these instances by reducing production time, increasing yield and consistency, reducing off-flavors and lowering costs.

There are many exogenous enzymes available to the brewer to use throughout the brewing process. Several enzymes can be used at multiple points in the brewing process, such as in the mash tun, kettle, fermenter or maturation tank. A large proportion of exogenous enzymes are used upfront in the brewhouse during mash conversion. Brewhouse enzyme additions can be used to improve mash extract, wort fermentability, lauter efficiency, and free amino nitrogen levels. Enzymes added to the brewhouse are able to do their job, but they are then denatured by boiling in the kettle, so their activity doesn't carry through to fermentation or into the package. **This gives the brewer greater control – You decide exactly when enzyme activity starts and stops.**

Enzymes can also be added to the fermenter (FV) or maturation tank to improve attenuation and filterability, correct haze, promote biotransformation and improve product stability.

Some enzymes are very costly and it can be confusing which ones to use and where. In this document we will cover the options available to the brewer.

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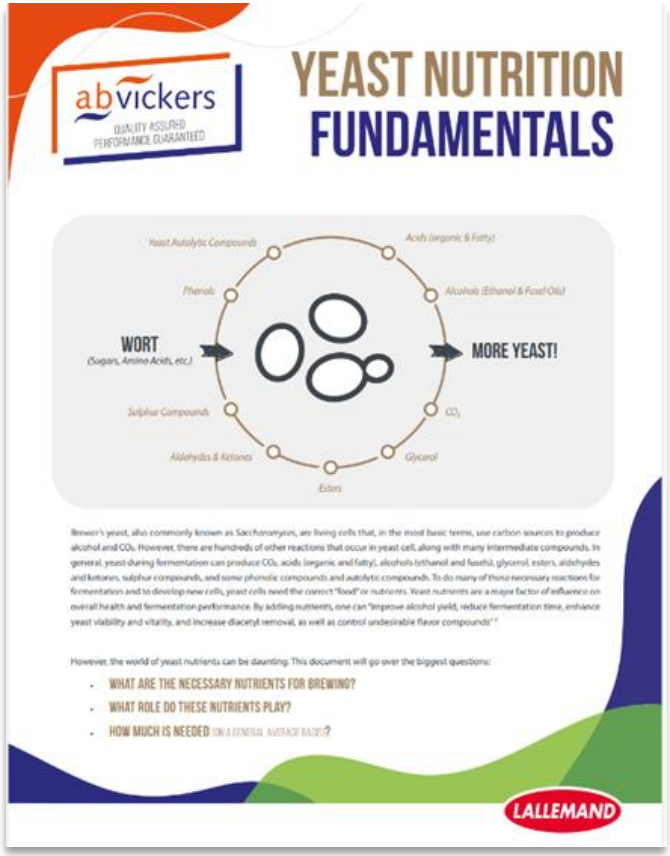

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YEAST NUTRITION FUNDAMENTALS

Brewer's yeast, also commonly known as *Saccharomyces*, are living cells that, in the most basic terms, use carbon sources to produce alcohol and CO_2. However, there are hundreds of other reactions that occur in yeast cell, along with many intermediate compounds. In general, yeast during fermentation can produce CO_2, acids (organic and fatty), alcohols (ethanol and fusels), glycerol, esters, aldehydes and ketones, sulphur compounds, and some phenolic compounds and autolytic compounds. To do many of these necessary reactions for fermentation and to develop new cells, yeast cells need the correct "food" or nutrients. Yeast nutrients are a major factor of influence on overall health and fermentation performance. By adding nutrients, one can "improve alcohol yield, reduce fermentation time, enhance yeast viability and vitality, and increase diacetyl removal, as well as control undesirable flavor compounds"[1]

However, the world of yeast nutrients can be daunting. This document will go over the biggest questions:

- WHAT ARE THE NECESSARY NUTRIENTS FOR BREWING?
- WHAT ROLE DO THESE NUTRIENTS PLAY?
- HOW MUCH IS NEEDED ON A GENERAL AVERAGE BASIS?

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BETTER BREWING *with* PROCESS AIDS

The first beers are thought to have been discovered by accident thousands of years ago. Grain became wet allowing the seed to germinate and produce amylolytic enzymes. These enzymes broke down the starch in the grain into simple sugars that were fermented by wild yeasts, and so beer was born.

The brewing process has evolved a great deal since then. We've traded ancient clay pots for stainless steel tanks with temperature control. Ingredients have also evolved. Clean water is easy to access. Modern malts have consistent levels of enzymes and proteins and are manipulated to produce a range of flavors. Hops are bred to have wildly diverse aromas and levels of bitterness. Yeast labs produce a variety of high purity strains to ferment different beer styles.

In addition to water, malt, hops and yeast, some brewers choose to make other additions throughout the process. Yeast nutrients boost fermentation performance and enzymes may be added to improve brewing efficiency, flavor or beer stability.

Process aids are also popular additions to beer as they can increase efficiency, reduce waste and improve the overall quality and profitability of the product. There are different types of process aids including finings, antifoam and stabilizers that can be used throughout the brewing process from brewhouse right through to maturation and storage (Figure 1).

FIGURE 1: Overview of brewing process and addition points for different types of brewing process aids.

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BEST PRACTICES

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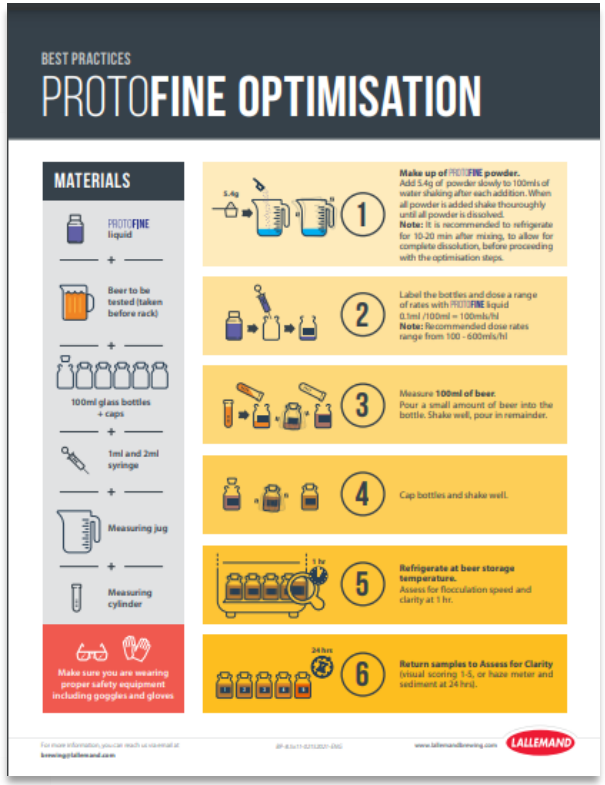
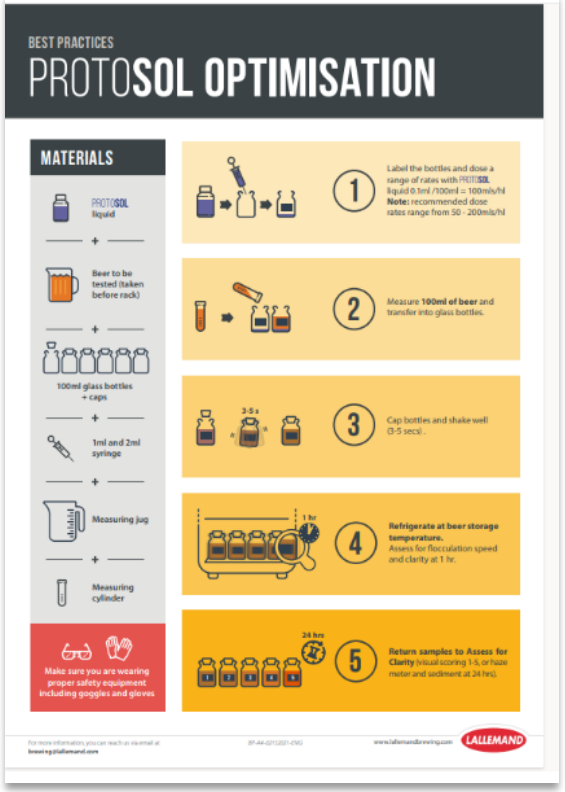
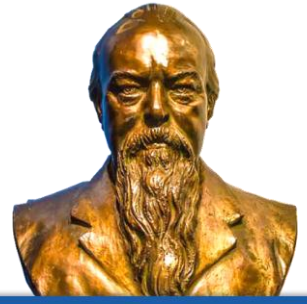




Siebel Institute
OF TECHNOLOGY



"The object of the institute is to promote the progress of the industries based on fermentation, which is done by instruction, investigation, analysis and otherwise."

Dr. John Ewald Siebel

Students from all over the world, since 1872

One common theme: fermentation

Approved by the Illinois Board of Higher Education

INTERNATIONALLY RECOGNIZED BREWING INDUSTRY EDUCATION AND SERVICE PROVIDER

About the Siebel Institute of Technology - Lallemand Brewing

- Can I reduce my cooling energy by **shortening maturation time**?
- Can I incorporate **renewable energy** into my process?
- Can I extend **yeast usage** through reuse?
- Can I lower malting costs by increasing **wort efficiency**?
- Can I **minimize hop quantities** by maximizing their use and encouraging **biotransformation**?
- Can I promote the use of **alternative packaging**?
- Can I utilize **locally sourced ingredients**?
- Can I **reduce water and cleaning** chemical usage?
- Can I **increase shelf life** to minimize the risk of products becoming unsellable?

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