BHF Technologies WISA Wine Industry Impact Award Application – Winemaking:

“Addressing climate change through genetically directed yeast selection for lower alcohol production”

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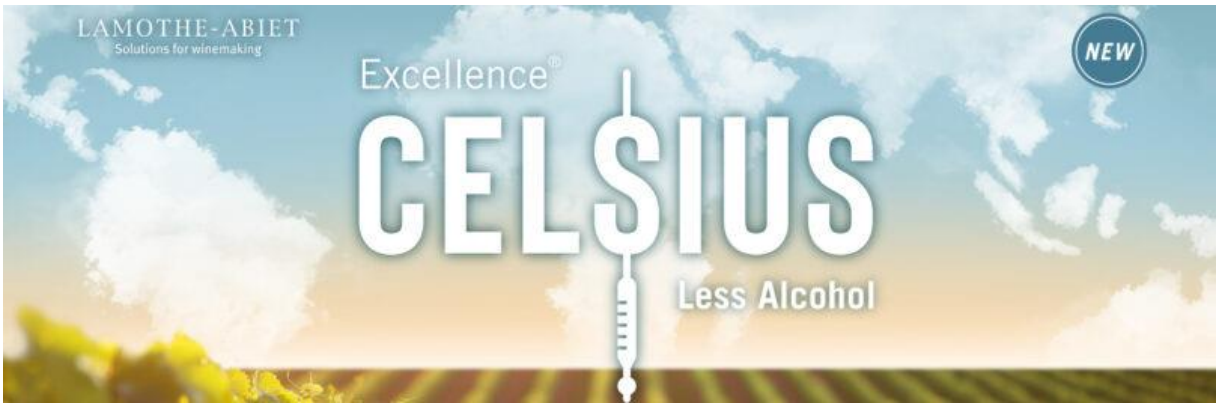


Table of contents

	Page
Overview and background	2
The problem	2
The solution	3
Industry impact	4

Overview and Background

BHF Technologies (formerly Blue H2O Filtration) has supplied oenological products and filtration consumables to the Australian wine industry for over 20 years. In all aspects of these product offerings quality and efficacy are foremost. Unlike most suppliers, BHF can channel intellectual property and products from many industries (pharmaceutical, dairy, mining etc) into the Australian wine industry, and this has yielded **significant impact** over the years, as evidenced by BHF's previous WIIA wins in 2016 and 2019 in the packaging category and again in 2022 for the newly minted sustainability category. BHF is also unusual in that it uses **multiple manufacturers**. Most suppliers represent only one brand of product. **BHF represents many manufacturers** and can recommend and supply the product that is the **most fit-for-purpose** rather than simply only the branded product that can be offered regardless of its suitability. This constitutes a **significant process advantage** for BHF's customers.

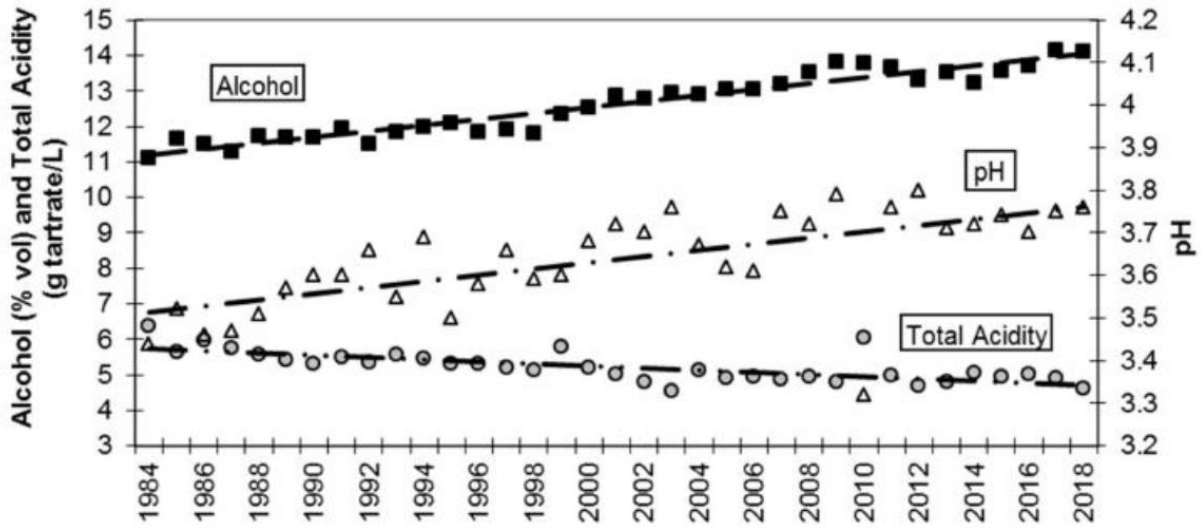
In 2016 BHF took on an additional supplier in the form of Lamothe-Abiet (LA), France's oldest oenological product supplier, with a view to expanding the product spectrum available to its customers. LA is at the cutting edge of oenological product development, having the science to support both product quality and development through partnership with the University of Bordeaux Institut des Sciences de la Vigne et du Vin (ISVV). Being based in Bordeaux, servicing the global wine industry and succeeding on the strength of its science and quality, LA offers a product range that spans the entire winemaking spectrum.

The problem

Globally, winemakers are struggling with the effects of a **warming climate** on vineyards and, by extension, the fruit they are making wines from. A warmer climate creates an imbalance in the sugar accumulation, phenological ripeness and natural acidity such that wines trend toward ever **increased alcohol levels** and require **greater acid inputs** at harvest, which has been well documented for Australian wines over the last 30 years.

As grapes ripen sugar accumulates, leading to higher final alcohol in the wine. In addition, greater fruit ripeness is accompanied by lower total (titratable) acidity and correspondingly higher pH, which constitutes an additional challenge in that acid adjustment is required to make the wine chemically stable and palatable. Higher ripening of the fruit can also increase the likelihood of stuck fermentations due to the correspondingly high alcohol production.

These points are all clearly presented in the below chart, which plots average wine alcohol levels, total acidity and pH over three decades. The problems of a rise in % alcohol, loss of acidity and increase in pH of fruit at harvest are obvious.



Whilst simply picking the fruit earlier would seem a plausible way to produce lower alcohol levels in the wine, this approach would afford wines with unripe flavours that would be of **lower commercial acceptability** and that deviate from the winery's style. Beyond that, two options only are currently available to address these higher alcohol levels: adding water or removing alcohol. Each of these mitigating approaches to the climate change problem presents its own problems, however. Simply adding water produces a wine diluted in alcohol but also **diluted in flavour and concentration**, leading to wines of lower quality. Removing alcohol through physical separation can yield a wine of good quality, but this comes at a **significant additional production cost**.

As neither of these remedies is commercially attractive, how then can Australian winemakers produce wines of equal quality yet with lower alcohol and without adding to the production cost?

The solution

A yeast selected through genetic targeting to produce less alcohol: **Excellence Celsius™**.

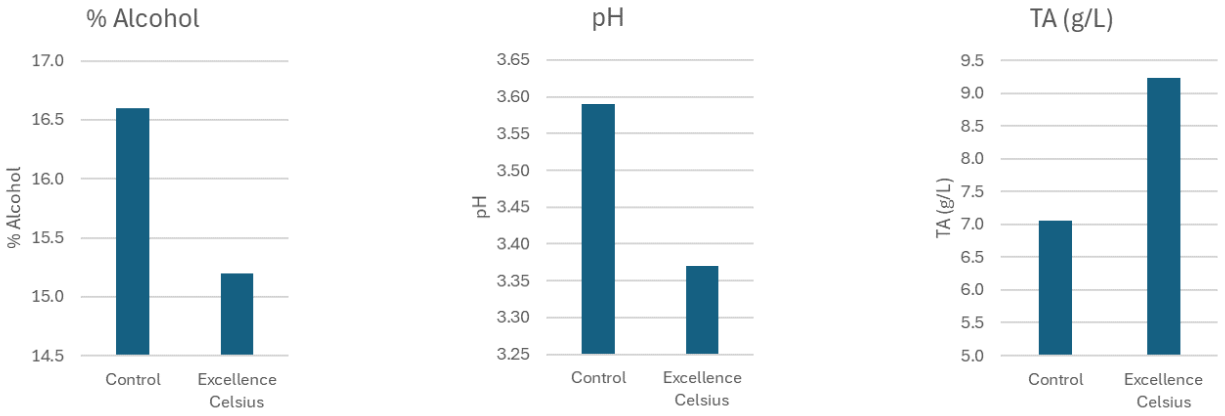
Yeasts vary in their efficiency in converting sugars to alcohol according to their genetic composition. A new genetic targeting technique (QTL; Qualitative Trait Locus; **non-GMO**) has been employed whereby yeasts can be screened at the genetic level to enable preselection for specific real-world traits, in this case for lower alcohol production and higher secondary metabolite production. The result of this process over the last 5 years is the commercial yeast **Excellence Celsius™**, which produces **less alcohol than other yeast strains**. This is achieved by Excellence Celsius™ converting some of the juice/must sugar to secondary metabolites during fermentation, specifically **L-malic acid and glycerol**. Both are positive contributors to the final wine in different ways. Excellence Celsius™ is homozygous for 86 % of targeted loci, meaning it is genetically ideal for producing less alcohol.

As grapes ripen sugar accumulates, leading to higher alcohol levels (ie "the problem"), but another result of this is **reduced fruit acidity** through the **decline of malic acid** as ripening proceeds. This is more prominent in warmer growing regions and the longer the fruit ripens but occurs in all grapes. This is typically corrected at the winery through the addition of tartaric acid, constituting an **additional and considerable processing cost** to the winery. Tartaric acid is used for this addition as it is microbially stable, but the wine profile is then no longer as nature intended, since malic acid has been degraded at the final stages of ripening. Without this correction of acidity, the resulting wine would suffer from premature oxidation, palate flabbiness and a greater likelihood of microbial spoilage. Excellence Celsius™ combats this problem by **converting some sugar to L-malic acid** (typically 1-2 g/L) during fermentation, thus boosting the wine's acidity and **reducing or negating the requirement for exogenous acid addition**. Glycerol is also produced by Excellence Celsius™ typically around 2 g/L through sugar conversion and is known to increase the perception of **palate weight and roundness** in a wine. Thus, both secondary metabolites produced by Excellence Celsius™ are positive contributors to wine chemistry and structure.

Australian trial results from vintage 2024

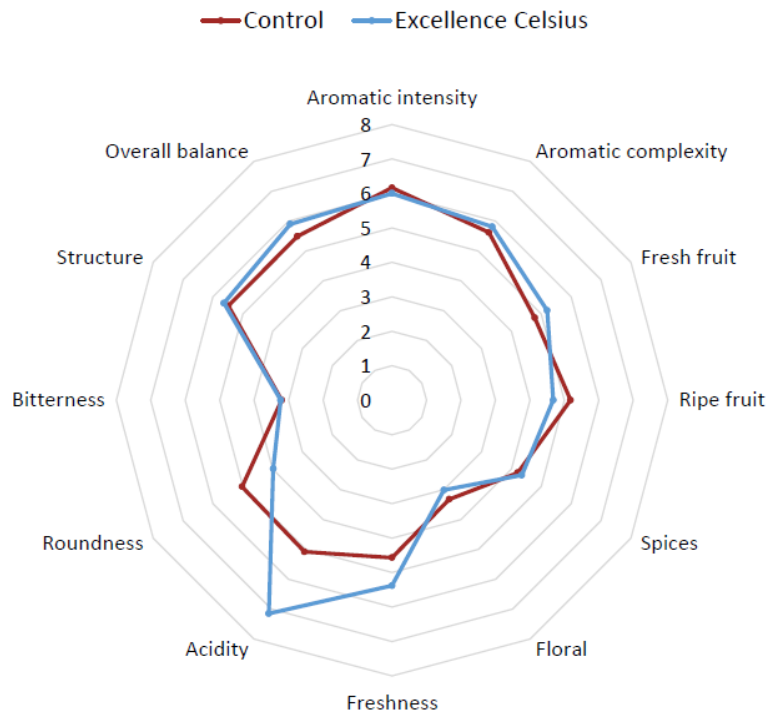
The results from two trials in the Coonawarra wine region are presented below. All winemaking conditions and parameters were identical except for the yeast strain used. The control yeast was Excellence XR™.

Trial 1: Cabernet sauvignon. Harvest analysis: 14.5 Bé, pH 3.50, TA 5.8 g/L. Data below are post-MLF.



Trial 2: Shiraz. Harvest analysis: 13.4 Bé, pH 3.5, TA 6.9 g/L. Data below are post-MLF.

An averaged radar plot of the sensory aspects of the wines from Trial 2 is presented below to provide some indication of how each wine compares organoleptically (n = 10).



Testimonial, Joe Cory, Trial 2:

"Winemakers must strike a balance between the ripe flavour profile that customers want and the high alcohol that usually goes with that fruit ripeness. These high wine alcohol levels require adjustment before bottling. Dilution of the wine leads to lower quality and the expense of alcohol removal is high. After trialing Excellence Celsius in vintage 24 I was pleasantly surprised to see a noticeable alcohol reduction and a very useful acid boost in the wine and, importantly, a wine that showed real stylistic promise. I am now able to make wines of lower final alcohol but with ripe flavours in a more cost-effective manner. Excellence Celsius will be a very welcome tool for winemakers of all wine types across many Australian regions."

Industry impact

BHF and its partner Lamothe-Abiet have provided a new product to the Australian wine industry to address one major and two lesser problems arising from a warming climate: higher alcohol, low acidity and higher pH. Excellence Celsius™ was strategically targeted at the genetic level to assist winemakers by producing less alcohol and increasing wine acidity. Australian winemakers can now continue to ripen their grapes to the required flavour level according to market and stylistic requirements, but still produce wines of **lower alcohol**. Extra benefits are delivered in that this can be achieved at **reduced production cost**, plus wine **acidity and freshness are increased with additional mouthfeel**. Given that ripe fruit typically requires a significant acid addition, the production of malic acid that Excellence Celsius™ affords constitutes a **reduction in required processing input costs**, so it is actually cheaper to make wine using Excellence Celsius™ than by using a standard wine yeast. Excellence Celsius™ is suitable for the production of white, red and rosé wines, and is thus a useful winemaking tool **relevant to all winemakers across Australia**.

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