

Brettanomyces – solving a wine spoilage problem

Adoption Impact

Overview and summary of impact

Brettanomyces ('Brett') is a yeast that is commonly found in wineries (and breweries). Molecular research by the Australian Wine Research Institute (AWRI) has shown that there are dozens of strains of Brett in Australia. It is found in wine and in barrels and persists through cross-contamination between the two.

Two decades of research and extension by AWRI, with funding from Wine Australia, has substantially reduced the cost to the Australian wine sector of spoilage associated with the presence of the yeast *Brettanomyces*.



The situation

Brett produces a range of volatile phenol compounds, principally 4-ethylphenol (4EP) and 4-ethylguaiacol (4EG). These compounds can impart undesirable sensory characteristics on wine including 'medicinal', 'leather', 'smoky', 'spicy', 'Band-Aid™' and 'barnyard'. These expressions depend on the ratio of compounds

produced, which is in turn related to the grape variety. Brett is also associated with reduced fruit flavour intensity and a drying, metallic aftertaste. Consumer studies by AWRI indicate that the concentration of Brett compounds in wine is strongly and negatively correlated with consumer liking.

The critical risk period for Brett spoilage is known as the 'Brett zone' – the period between the end of primary and secondary fermentation, and before the addition of sulfur dioxide – especially when residual sugars are available to the yeast. Slow or stuck malolactic ferments increase the risk.

Brett is an international problem, having been described in Bordeaux (France) and the USA, for example. It primarily affects red wines.

Connection with research and extension activities

In 1998/99, researchers at AWRI developed analytical techniques for measuring oak flavours, including 4EP and 4EG. Extensive testing of samples indicated a much higher than expected prevalence of the compounds in Australian wines and therefore of Brett.

With the realisation of the extent of the problem, AWRI commenced a major research program on Brett, mainly between 2001/02 and 2007/08. The aims of the research were to:

- Monitor the prevalence of Brett across Australia
- Determine which wine composition parameters favoured or prevented Brett growth, including sweetness, alcohol, acidity, pH and SO₂
- Identify flavour compounds that characterised Brett
- Describe Brett characters in different wine styles, determine threshold levels and consumer-liking
- Understand why wines of some varieties produced more Brett-associated spoilage compounds than others and what the precursor compounds were
- Develop methods to isolate Brett using media (which was reportedly not possible), and
- Collect Brett yeasts from across Australia to determine if all Brett yeast were the same, using new DNA techniques and later using molecular sequencing.

More recent research has focused on genetic characterisation of the yeast and understanding the reasons behind SO₂ tolerance in the different strains. Adaptive evolution of the yeast to SO₂ has been recently identified which may require future alternate control measures.

Control strategies for Brett have been progressively refined as AWRI researchers have tested ideas and observed outcomes of interventions adopted by wineries, particularly those with significant Brett spoilage issues. The research has produced many spinoffs in other areas of wine quality, such as reductions in the concentrations of volatile acidity and greater expression of fruit, regional or varietal

character, involving collaborations with research groups at the University of Adelaide, in Bordeaux, in Chile and elsewhere.

AWRI promotes a strategy comprising eight major planks for Brett control, central to which are sanitation, reducing the duration of malolactic fermentations and smarter use of SO₂. AWRI makes this information available in web-based materials including a fact sheet, as well as helpdesk support and a commercial Brett audit service. Seminars and workshops for winemakers have also been an important part of the delivery. Seminars were conducted across Australia in 2002 at the start of the project. Control strategies for Brett were detailed as part of workshops on instabilities and wine faults during 2001-2006, and participants were shown how to isolate Brett from wine and identify it using a microscope. 'Bretty' wines were also tasted so winemakers could identify these better in practice. Brett workshops were delivered at the 2004 and 2007 Australian Wine Industry Technical Conferences. These workshops then became part of ongoing 'Taints' workshops.

The research effort has also led to the development of a range of products and procedures to control Brett, such as reverse osmosis technologies to remove 4EP, quick self-test kits (Veriflow®) to detect Brett yeast in wine and online calculators for molecular SO₂ and nitrogen (YAN).

Details of the impact

A benefit-cost analysis of the Grape and Wine Research & Development Corporation's investment in Brett research and extension between 1999 and 2008, through AWRI, was conducted in 2012 by Econsearch. The study estimated a \$42.1 million net present value from the \$3.2 million investment using a 5% discount rate. The benefits realised were primarily avoided losses due to downgraded wines (\$31.9 million) and reduced winery management costs (\$11.0 million).

Evidence of changes in the extent of Brett comes from direct measurement of 4EP in Australian wines. In the mid-2000s, a survey was undertaken in commercially available cabernet sauvignon wines from five regions over nine vintages to 2005. The observation of year-on-year increase in queries about Brett to the AWRI helpdesk leading up to 2018 prompted a repeat of the survey, this time on wines from the 2015 vintage from the same regions.

Data from the two surveys shows that between 1997 and 2015 vintage years, the mean concentration of 4EP in cabernet sauvignon steadily decreased from 1251 to 29 µg/L. Whilst almost no wines were free from detectable 4EP in 1997, over 60% of wines fell into this category in 2015 and no viable *Brettanomyces* yeasts were isolated from any of the wines.

Indirect evidence for the implementation of control measures to control Brett is available from compositional data on wines submitted to AWRI for analysis since 1984. Between 1984 and 2014, there has been a strong upward trend in the ratio of free to total SO₂ in red, white and rosé wines, which suggests that winemakers are using SO₂ more effectively and according to the strategies developed by AWRI. Notably, this trend has occurred despite a marked increase in the pH of wines over the same period, which would act to reduce the concentration of the free form of SO₂.

Relevance to others

The case study provides an excellent example of pragmatic, problem-focused research. There is evidence of strong adoption of identified solutions, which can probably be attributed to:

- The research and development being undertaken in concert with sector participants
- The development of clear, readily actionable solutions
- The extension of these solutions through multiple channels including workshops, with a strong hands-on component along with the Wine Australia funded helpdesk managed by AWRI, and
- The monitoring and demonstration of progress towards addressing the problem, using real industry data.

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