
Technical note

Understanding the effects of lees contact in white wine

In 2016, the AWRI began conducting a series of winemaking trials where a single batch of grapes was divided into smaller lots with one winemaking variable changed in each fermentation. This produced a range of wines over several vintages, which were then presented at AWRI workshops staged across Australia. A different variety was used each vintage, with the trials covering Pinot Noir, Shiraz, Cabernet Sauvignon and Chardonnay. This article reviews post-fermentation lees contact in white wine production, one of the treatments included in the 2019 Chardonnay winemaking trial.

Background

Allowing a period of post-fermentation contact between fermentation lees and the wine is a traditional technique in many parts of Europe. It is most commonly associated with barrel-fermented Chardonnay in Burgundy where the term ‘*sur lie*’ or ‘on lees’ originated to describe the practice. Many winemakers believe that this practice improves the complexity and texture of white wines and it is not uncommon for still white wines to be left in contact with lees for months after fermentation.

What is in lees and what happens during lees contact?

White wine fermentation lees contain yeast cells, tartaric acid salts, bacteria and grape solids (Salmon et al. 2000). During a period of lees contact, components of yeast cells are released into wine, which, coupled with other mechanisms, can result in an enhancement of the wine’s sensory characters. If ageing on lees is appropriately managed, reported benefits include improved texture, a modification of oak aromas and flavours, and improved integration of oak-, fruit-, and yeast-derived characters resulting in greater complexity. The periodic stirring of lees to bring yeast cells back into suspension is known as ‘*batonnage*’ and can be used to increase the sensory effects of lees contact.

Benefits reported from ageing wine on lees

The most important yeast cell-derived compounds that improve wine sensory properties are amino acids, polysaccharides, mannoproteins and fatty and nucleic acids (Stuckey et al. 1991, Salmon et al. 2000). The presence of yeast cells can also lead to the production of positive characters through oxidation reactions. Nagy et al. (2017) report that yeast autolysis is a slow process and occurs between 12 and 18 months, with intracellular compounds being released after one year. In addition, the extraction of macromolecules from the yeast, such

as mannoproteins and proteins, as well as saturated fatty acids and glutathione, significantly increases when the lees are repeatedly re-suspended by stirring.

During barrel fermentation and lees ageing, yeast cells convert vanillin to vanillic alcohol, which is virtually odourless, thereby reducing 'vanilla-like' aromas, while the 'toasty' aromas associated with oak are enhanced (Dubourdieu et al. 2000). In addition, oak tannins and other phenolic compounds are adsorbed onto yeast cells, resulting in a softening of mouthfeel, with one study finding that the total phenolics of a Chardonnay wine on lees fell over a two-month period, whether or not the lees were stirred (Leskó et al. 2011). Increases in the concentrations of other volatile compounds including esters, terpene alcohols and lactones have also been reported.

Amino acids in wine have been related to enhancements in both texture and aroma. In one study, after five months of lees ageing the concentrations of amino acids in stirred and non-stirred wines on lees were 257 mg/L and 282 mg/L respectively, compared to 197 mg/L in a non-lees aged, non-stirred control. Sensory differences between the stirred and non-stirred wines and the control became evident between three and five months, with the concentration of amino acids increasing markedly between those time-points. A strong positive correlation between amino acid concentration and wine score was seen with the non-stirred wine on lees receiving the highest score (Stuckey et al. 1991). A positive relationship between amino acid concentration and more complex wine aroma has also been reported, with increased amino acid concentration also stimulating malolactic fermentation.

Another benefit of lees ageing is the ability of lees to scavenge oxygen entering through the barrel staves and bunghole, especially when stirring occurs. This oxygen-scavenging capacity can reduce the amount of SO₂ otherwise required to prevent oxidation, although excessive stirring can introduce excess oxygen, leading to the loss of SO₂ and potentially the formation of acetaldehyde and acetic acid.

It should be remembered that topping barrels during the period on lees also introduces additional oxygen. In a trial reported by Brajkovich (2008), a barrel-fermented Chardonnay on lees and stored at 15°C was subjected to four treatments:

1. Barrels neither stirred nor topped
2. Barrels topped every two weeks without stirring
3. Barrels stirred every two weeks without topping
4. Barrels topped and stirred every two weeks.

After four months there were no analytical differences in the concentrations of either SO₂ or acetaldehyde between the wines, but during sensory evaluation treatment 1 (barrels neither stirred nor topped) was preferred. The wine was described as “... fresher and with more varietal definition ... less signs of oxidation or the dullness that can be the result of excessive batonnage”.

Practical tips

Lees ageing is most commonly performed in small oak barrels, because lees ageing in tank is more likely to result in the formation of unwanted volatile sulfur compounds (VSCs). When unwanted VSCs are present in a tank-fermented wine at the end of fermentation or during a period of lees ageing, transferring the lees into barrels for 48 hours and then recombining them with the wine has been found to completely eliminate ethanethiol and methanethiol within 24 hours, with the concentration of hydrogen sulfide also falling by over 80% during the following four weeks (Lavigne-Cruège and Dubourdiou 2001).

The stirring of lees encourages continued cell viability, and while it has been shown that cell viability is not an important factor in the sensory changes associated with lees contact, viability does encourage the assimilation of any residual sugar. For this reason, a small amount of stirring at the end of fermentation is recommended.

Potential risks

The greatest potential risks with lees ageing are the formation of unwanted VSCs and associated ‘leesy’ or ‘cheesy’ sensory characters, and the formation of acetaldehyde and acetic acid. Unwanted VSCs are more likely to form when initial juice solids are above 200 NTU, or when insufficient oxygen is introduced by stirring, with acetaldehyde and acetic acid being more likely to form when excessive oxygen is introduced by stirring and topping (Lavigne-Cruège and Dubourdiou 2001).

The formation of biogenic amines in Chardonnay aged on lees for 180 days has also been studied (González-Marco and Ancín-Azpilicueta 2006), with the concentrations of tyramine and histamine found to be higher than in the same wine stored in barrels without lees. Amine concentrations were higher when the wine was stirred once a week, and the rate of increase was constant between days 100 and 180. This suggests that the concentrations would have continued to increase beyond 180 days, particularly if the lees were stirred, and it is possible they could reach problematic levels for sensitive individuals.

Lees contact treatment in the 2019 Chardonnay trial

A ‘lees-aged and stirred’ treatment was included in the 2019 Chardonnay winemaking

treatments trial. Cold-settled whole bunch-pressed juice with a 3% 'light and fluffy' juice lees addition was fermented in two 45-litre stainless steel containers with Lallemand CY3079 yeast, with 200 mg/L of diammonium phosphate added on day four. The concentration of malic acid was determined at the completion of all the fermentations, and it was found that the two portions intended as the 'lees aged and stirred' treatment had spontaneously completed malolactic fermentation by that time. The wine was then left in contact with the fermentation lees and stirred weekly for eight weeks as originally intended.

The starting malic acid concentration was 1.79 g/L, and while all the fermentations were found to have undergone a small degree of spontaneous malolactic fermentation, only the 'lees aged and stirred' portions and the 'fermented on skins'/ 'amber wine' treatment were found to have completed malolactic fermentation, with 0.74 g/L of malic acid having been degraded in the non-yeast inoculated 'natural fermentation' portions to which no SO₂ had been added at crushing.

The trial also included an inoculated malolactic fermentation treatment which at the end of fermentation was found to still contain 0.42 g/L of malic acid. While this treatment was later found to have completed malolactic fermentation, the 'lees aged and stirred' treatment was assessed as having a more typical malolactic character at the time of bottling in November 2019. During subsequent presentations of the wines, therefore, the intended 'lees-aged and stirred' treatment was presented as a combined 'lees aged and MLF treatment', noting that contrary to the intent of the trial, two winemaking variables had been changed in the wine.

While at the time of bottling some diacetyl-like 'butteriness' was evident, probably associated with the malolactic fermentation, that character had largely dissipated by the time industry presentations were made in January and early February 2020, and was absent when subsequent presentations were made in mid- and late-2020. During those presentations, participants almost universally recognised a fuller texture in the wine compared to the control which might be attributed to both the lees contact and the malolactic fermentation, but a low level 'grubby/dirty/cheesy' aroma was also widely noted. Consequently, this treatment was not one of the preferred wines in any of the tastings.

Acknowledgements

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The AWRI will be closed over the Christmas/New Year period from midday on Thursday, 24 December 2020 and will re-open at 8:30 am on Monday, 4 January 2021.

AWRI Commercial Services

The Commercial Services laboratories will be closed from midday on Thursday, 24 December and will re-open at 9:00 am on Monday, 11 January 2021.

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Library

The John Fornachon Memorial Library will be closed from 5:00 pm on Wednesday, 23 December and will re-open at 9:00 am on Monday, 11 January 2021. Access to the library's online database will continue to be available 24 hours a day, 7 days a week during this period via the AWRI website.