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Effectiveness of winery products/techniques on reducing negative sensory impacts in wine made using powdery mildew affected fruit

Test Case Winery Trial #3



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Introduction

Powdery mildew (*Erysiphe necator*) has an increasing prevalence in New Zealand vineyards. It develops under relatively dry, but humid conditions. It infects all living plant tissue, including leaves, shoots and young berries (Stummer et al., 2008).

The first symptoms of powdery mildew are seen as grey powdery growth on leaves (on both upper and lower surfaces) and bunches. These symptoms are often seen from mid-season onwards and once established are very difficult to treat (Stummer et al., 2008).

Powdery mildew infections of bunches can severely impact quality causing reduced berry size, delayed maturity and berry splitting. Powdery mildew infected grapes can result in off-flavours in wine and are usually downgraded or rejected at the winery.

If powdery mildew affected grapes are used in winemaking the resultant wines often have a distinctive musty/fungal aroma and have increased bitterness (Scott et al., 2010). With red wines, a loss of anthocyanin concentration in infected berries has a negative effect on colour intensity (Scott et al., 2010).

Juice from powdery mildew affected grapes is much more fragile than healthy grapes and is prone to oxidation which leads to premature aging and browning of the subsequent wine (Steel et al., 2013).

Objectives

There are several techniques and products available to winemakers to remove or reduce the negative sensorial impacts of powdery mildew in finished wine.

The objectives of the trial are:

- to trial three different products/techniques used to minimise sensorial defects caused by powdery mildew fruit
- to measure colour intensity and hue of the resultant wines one year post-bottling
- to analyse the sensory properties of the resultant wines one year post-bottling
- to compare the effectiveness of the products/techniques and report on the outcomes

Methods

Scope

Three products/techniques were compared to trial their effectiveness against powdery mildew off-aromas and colour loss/browning.

Chitosan

Chitosan is a natural biopolymer extracted from the shells of crustaceans or from the fungi *Aspergillus niger*. It has inherent antimicrobial properties and is used alongside SO₂ to inhibit detrimental microbial spoilage when using diseased grapes in winemaking (Longo, 2021). At low concentrations, chitosan binds to the fungal cells, ruptures the cell membrane, and causes death of the cell by causing intracellular components to leak out (Atay, 2020).

Tannins

Tannins have both antioxidant and antimicrobial properties. Tannins act as co-pigments which can protect anthocyanins from oxidation, helping to reduce browning and colour loss in juice and wine. As an antimicrobial, tannins can inhibit microbial enzymes and cause the destabilisation of the plasma membrane of yeast and bacteria (Campos et al., 2016).

Pasteurisation

The use of heat to inactivate unwanted microorganisms and denature enzymes is a well-known technique in many food industries (Golombek et al., 2021). The most efficient pasteurisation technique for juice/wine is flash pasteurisation, which consists of heating juice/wine to 80 degrees for 30 seconds then taking the liquid back to normal temperature as quickly as possible (Vintech Pacific, 2020). Another option is to heat the wine to 40 degrees, keep it at that temperature for 2 hours then cool. The wine is then inoculated with malolactic bacteria.

Trial Protocol

Fruit receipt

Pinot noir fruit was received at Bragato Research Institute from Central Otago on 14 April 2022 with a powdery mildew disease prevalence of 10%. The fruit was split into 4 batches, each with the same level of powdery mildew infection.

The grapes were 100% destemmed, crushed and 182kg put into each of four 200L open-top fermenters with the following treatments (Table 1) added at juice. Juice analysis was conducted and can be found in Table 2.

Table 1. Batch and additives pre-ferment

Treatment	Additives	Wine Code
Control	120ppm PMS	Wine A
Chitosan	120ppm PMS 8g/hL EnartisStab Micro M with <i>Aspergillus niger</i> extracted chitosan	Wine B
Pasteurization @ 40°C for 2 hours	120ppm PMS	Wine C
Tannins	120ppm PMS 10g/hL IOC Essential Antioxidant Gallic Tannin	Wine D

Table 2: Juice analysis

		Wine A	Wine B	Wine C	Wine D
Total acidity	g/L	5.61	5.33	5.7	5.36
L-Malic acid	g/L	3.2	2.61	3.03	2.74
pH		3.66	3.76	3.72	3.78
°Brix		23.5	23.9	23.4	23.3
YAN	mg/L as N	193	202	210	214

All tanks were adjusted to pH 3.3 with tartaric acid prior to inoculation, set to 10°C and hand-plunged once per day for three days for pre-fermentation maceration.

Fermentation

Tanks were warmed to 22 °C. Each batch was inoculated with Laffort RB2 yeast at 200ppm and Laffort Dynastart as a yeast protectant at 200ppm. Each batch was hand-plunged once per day during alcoholic ferment.

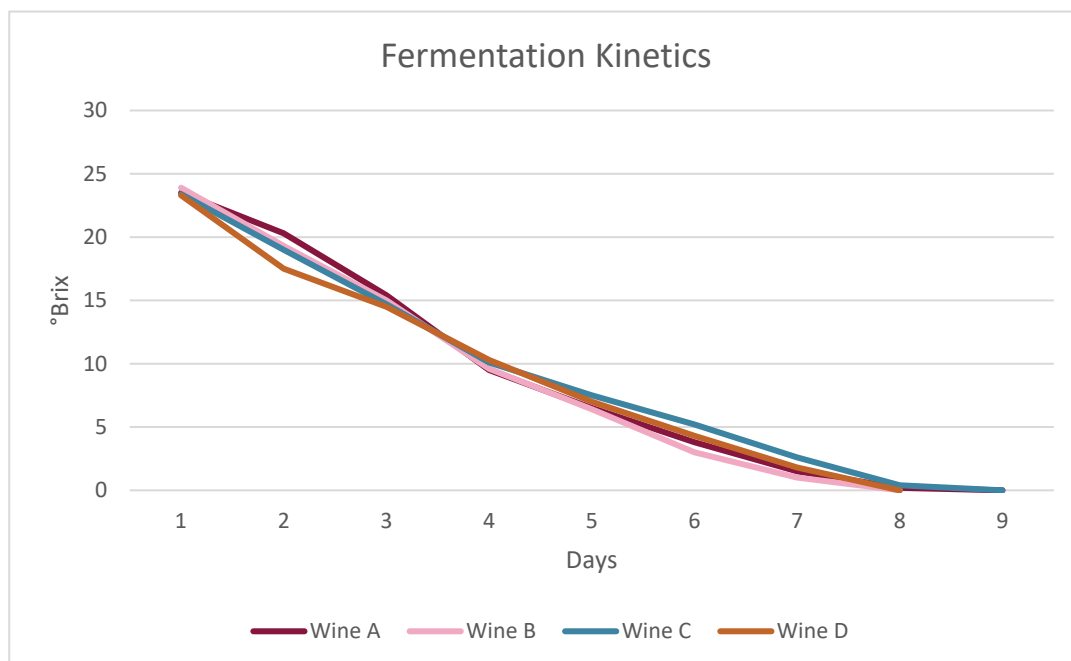


Figure 1. Daily ferment tracking

On enzymatic Glu/Fru reaching < 0.5g/L the Control, Chitosan and Tannin treatment batches were inoculated with VP41 bacteria to initiate malolactic conversion.

On Glu/Fru reaching < 0.5g/L the Pasteurisation batch was heated to 40°C and held at this temperature for 2 hours before cooling down to 18°C. This batch was then inoculated with VP41 bacteria to initiate malolactic conversion.

Post Ferment Treatment

All batches were pressed 15 days post the start of alcoholic fermentation using a Diemme Hydraulic Press.

When enzymatic testing showed malic acid = 0g/L all tanks received 140ppm PMS and tanks cooled to 10°C.

All tanks were fined to soften phenolics using egg white at the rate of 10g/hL. Once racked off egg whites, all tanks were adjusted to pH 3.5-3.6 with tartaric acid for microbial and oxidative stability and the final pre-bottling analysis was undertaken (Table 3.)

Batches were adjusted to approximately 30mg/L free SO₂ before filtering through 5 micron pad filter and 1.2 micron membrane filter then bottled into 750ml bottles utilising an Officine Pesce Bottling System under inert gas, then sealed with a screwcap. Bottled wines were stored at 10 °C.

Table 3. Wine Analysis pre-bottling

		Wine A	Wine B	Wine C	Wine D
Alcohol strength	%v/v	13.84	13.9	13.89	13.7
Total acidity	g/L	6.61	6.4	6.4	6.25
Volatile acidity	g/L	0.59	0.45	0.68	0.49
L-Malic acid	g/L	0	0	0	0
pH		3.62	3.59	3.62	3.59
Residual Sugar	g/L	0.4	0.4	0.4	0.4
Free SO ₂	mg/L	29	30	32	29

Results

Colour Analysis

Colour analysis was conducted at Pacific Rim Oenology one year post bottling using CloudSpec, a new UV-Vis technology that can measure turbid samples.

The CloudSpec generates full UV-Vis spectra from 250-850 nm. Absorbance (A) readings were taken at 420 nm (yellow pigments), 520 nm (red pigments), 620 nm (blue pigments) and 280 nm (total phenolics). The hue (a simplistic measure of the appearance of the colour) can also be found in Figure 2. Young red wines have a value on the order of 0.5–0.8 which increases throughout aging, reaching an upper limit of around 1.2–1.4. The colour density values (a simple measure of the darkness of the wine) were calculated and results can be found in Figure 2. Total phenolics can be found in Figure 3.

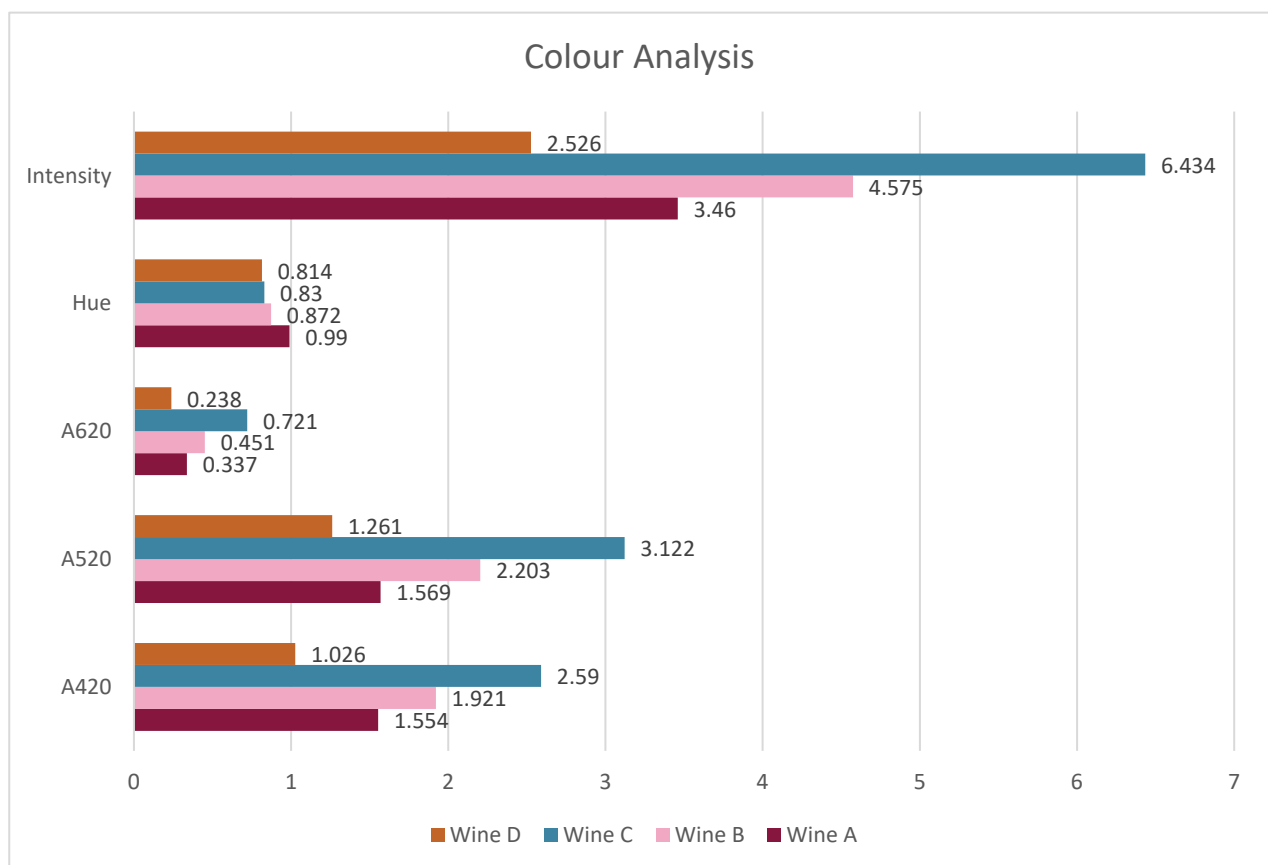


Figure 2. Colour Analysis for Pinot noir Powdery Mildew Trial

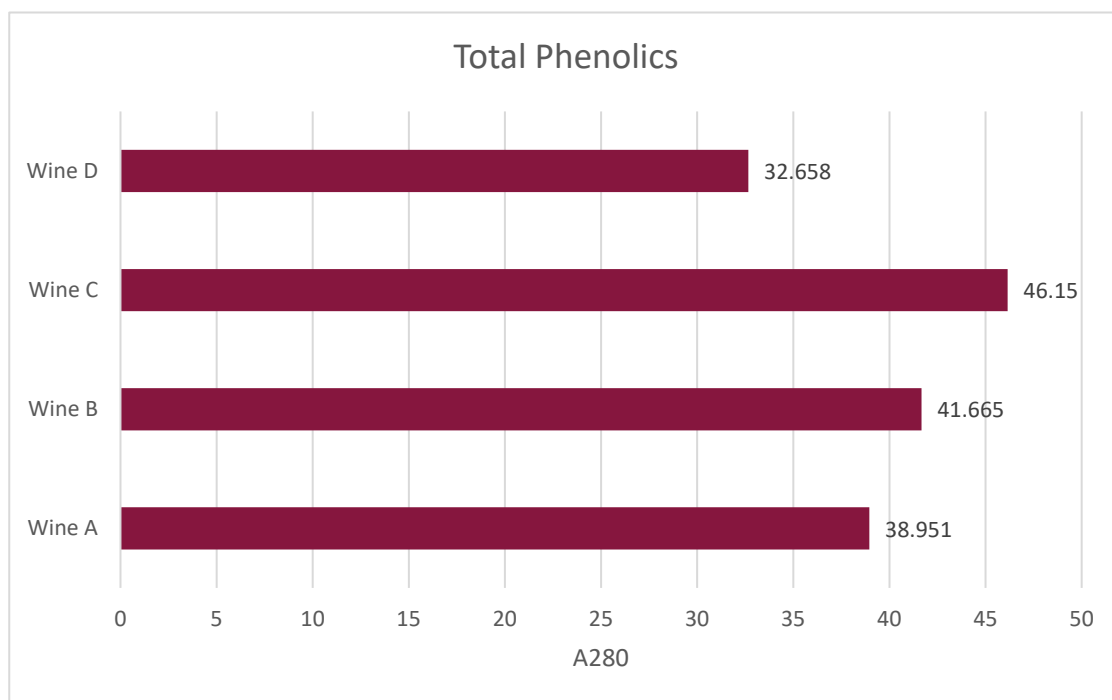


Figure 3. Total Phenolics for Pinot noir Powdery Mildew Trial

Sensory Analysis

Sensory Analysis was conducted by a panel of 15 winemakers experienced in making Pinot noir, 9 male and 6 female, aged between 26 and 59 on 8 September 2023. A standardised pour of 40ml of each wine was presented to the panel. Each wine was coded with A, B, C or D with the panellists not aware of which treatment related to each code. The panellists analysed the wine by olfaction and gustation and used the same tasting mat as per the Test Case package to record their analysis. The panel results are available in a sealed envelope in the Test Case Package.

Discussion

All fruit processing was undertaken with no issues and fermentation tracked at a standard rate to completion for all treatments. The chemical composition of all treatments was within the usual parameters typically found in finished Pinot noir wines. However, both the control and Wine C – Pasteurisation had increased levels of Volatile Acidity when compared to the Chitosan and Tannin treated wines.

All wines, regardless of treatment, still showed a musty/fungal aroma to some degree in the finished wine. The wine most preferred by the sensory panel was Wine C – Pasteurisation. The panellists found this wine to show lower levels of musty/fungal aroma, higher levels of dark fruits, riper and more integrated tannins and higher colour intensity.

The process for pasteurising this wine (2 hours at 40°C) was difficult to achieve in the Bragato Research Winery. For commercial wineries contemplating this technique, the more common Flash Pasteurisation is recommended.

When comparing the colour analysis, the tannin treated wine – Wine D, had a more youthful hue, perhaps indicating the added tannins protected the juice and wine from oxidation during processing. Overall, the Pasteurised wine – Wine C had higher levels of pigments at all absorbencies than either the control or other treatments, as well as a higher intensity of colour.

In summary, no treatment removed the musty/fungal aromas associated with powdery mildew affected fruit completely. An increase in aroma and colour quality was seen with pasteurisation and a decrease in oxidative impact on colour with tannin addition. To minimise sensorial impact from powdery mildew fruit it is still recommended to remove as much of the affected fruit as possible before processing in the winery.

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