Exploring the impact of malolactic co-inoculation on chemical and sensory characteristics of the wine and cellar efficiency

Ingleside Vineyards

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Introduction

Like many Virginia wineries, the standard protocol for malolactic fermentation at Ingleside has historically been sequential inoculation with a commercial strain of *Oenococcus oeni*. After inoculation, barrels were set in a single layer with frequent stirring to encourage the completion of malolactic fermentation. In 2022, malolactic fermentation was slow to finish, leading to space and labor inefficiency. One solution to this inefficiency may be the co-inoculation of malolactic fermentation 24 – 48 hours post inoculation with *Saccharomyces*. Coupled with extended maceration (also standard protocol at Ingleside), co-inoculation may allow wines to complete malolactic fermentation before they are transferred to barrel, allowing for addition of SO_2 to topped barrels with solid bungs before the cellar gets cold for the winter. The purpose of this experiment was to compare cellar efficiency, chemical and sensory outcomes of sequential vs. co-inoculation of malolactic fermentation in Ingleside red wines.

In this experiment, two treatments were employed:

- Sequential inoculation of red wines
- Co-inoculation of red wines 24-48 hours after yeast inoculation

Methods

Petit Verdot fruit was hand harvested, chilled overnight, then destemmed to TBins with the addition of FT Rouge Berry (30 g/hL) and oak chips. Saignée of 5-8% of the volume was done post de-stemming, with an equal proportion removed for each treatment within a lot. Fermentation was inoculated with 25 g/hL commercial yeast (MT yeast (PV1) or ICV D254 (PV2). Sugar (22 g/L) and acid additions (2 g/L) were also done on day 2 of fermentation. Stimula Cab Sauv (40 g/hL) was added on day 3. Fermentations were allowed to macerate for 3 weeks prior to pressing. Wine settled in tank for one day, then was transferred to barrels. At the completion of malolactic fermentation, 80 ppm SO2 (14 g/hL KMBS) was added to the wine. Wine was racked in December. *Oenococcus oeni* (Silka, Lallemand) was added to the co-inoculated treatments 2 days post inoculation and to the sequential inoculated treatments after the completion of fermentation.

Similar treatments were done in Merlot and Sangiovese. Results for all four lots are reported below.

Results

Table 1: Juice chemistry for three lots used for experimentation (Imbibe Solutions)

	Date	Brix	pH	Titratable Acidity (g/L)	Malic Acid (g/L)	YAN (mg/L)
Sangiovese	9/21	19.9	3.39	8.3	1.82	88
Merlot	9/26	18.2	3.71	5.4	2.35	217
Petit Verdot	10/3	20.3	3.59	7.5	3.52	145

Fruit came in with relatively low Brix. Malic acid values ranged from relatively low (Sangiovese) to relatively high (Petit Verdot) (Table 1). Fermentation kinetics in Petit Verdot were very similar regardless of yeast strain or treatment group (Figure 1). Fermentation temperature peaked between 84-86□F. All wines finished fermentation with RS < 1.00 (ICV Labs, November 2024), regardless of variety, yeast, or treatment condition.

Figure 1: Fermentation kinetics of sequential and co-inoculated Petit Verdot using two commercial yeast strains (PV1 = MT yeast, PV2 = D254)

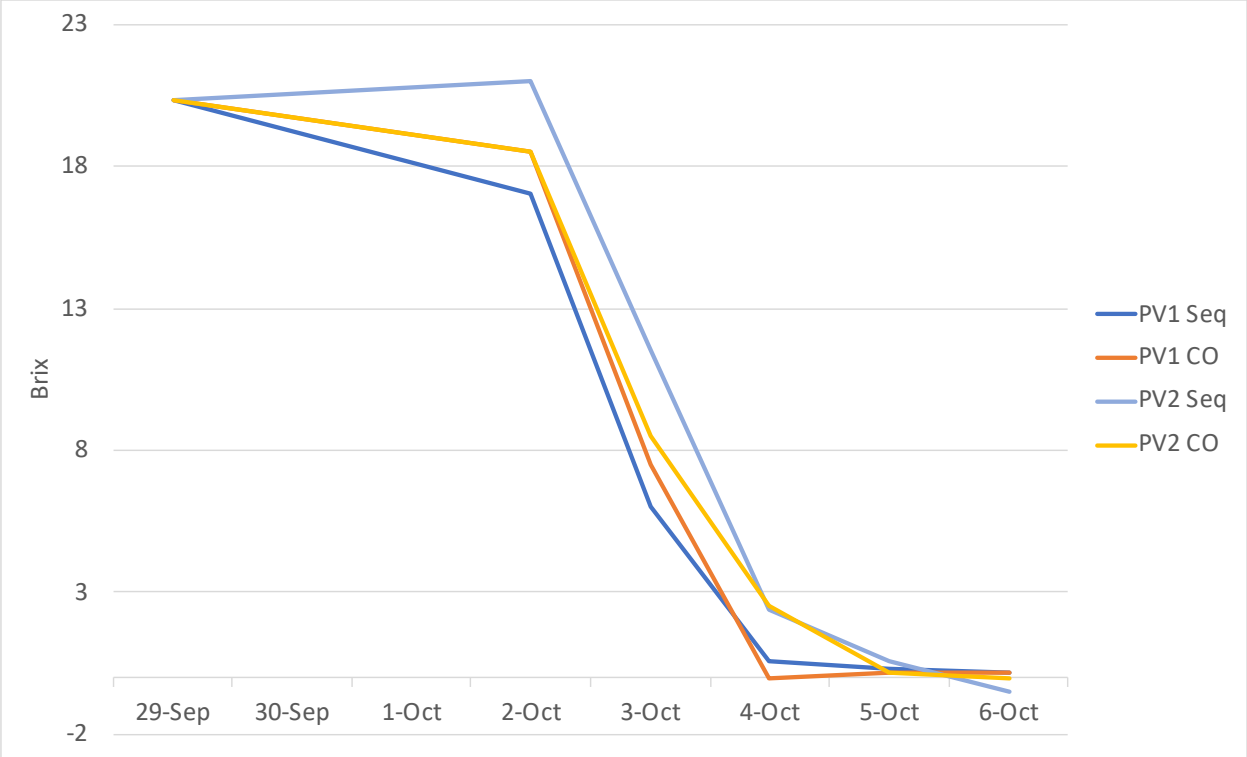
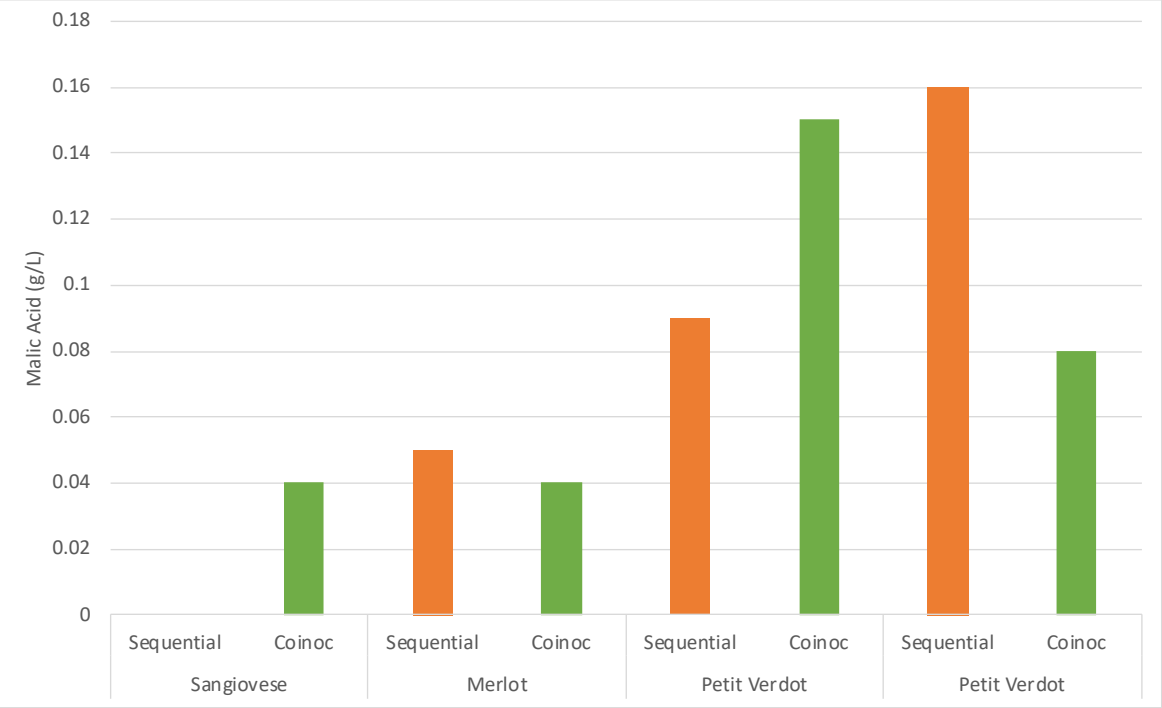


Figure 2: Malic acid concentration at pressing (November 17, 2023; Imbibe solutions)



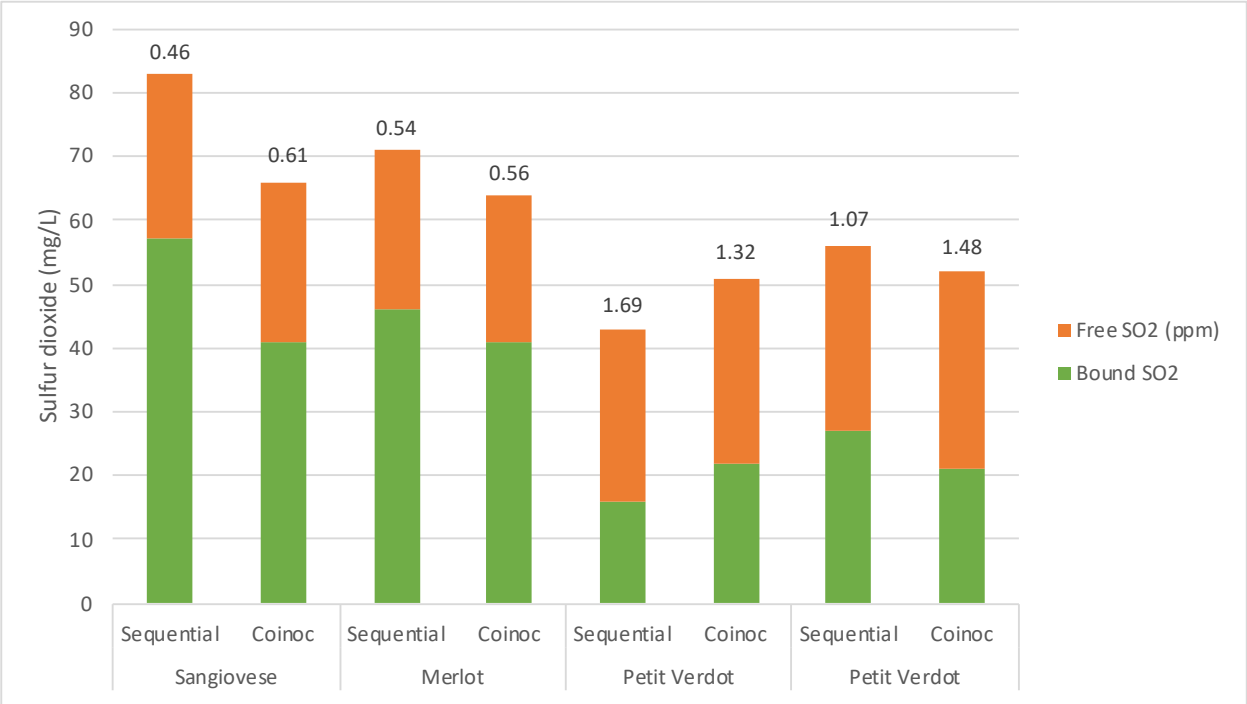
At the end of extended maceration, each of the wines contained less than 0.2 g/L of malic acid, regardless of inoculation timing (Figure 2). None of the co-inoculated wines had finished malolactic fermentation at this time while one of the sequential inoculation wines had (Sangiovese).

Table 2: Wine chemistry after the completion of malolactic fermentation for four lots of experimental wines (ICV Labs, December 2024)

		Ethanol (%)	pH	Titratable Acidity (g/L)	Acetic Acid (g/L)	Lactic Acid (g/L)
Sangiovese	Sequential	11.57	3.7	5.36	0.48	1.14
	Coinoc	11.46	3.74	5.27	0.59	1.24
Merlot	Sequential	11.5	3.65	5.76	0.44	1.37
	Coinoc	11.62	3.69	5.82	0.54	1.45
Petit Verdot	Sequential	11.46	4.02	6.41	0.75	2.34
	Coinoc	11.62	4.11	6.2	0.75	2.57
Petit Verdot	Sequential	11.88	3.82	6.11	0.86	1.86
	Coinoc	11.98	3.98	5.79	0.77	1.99

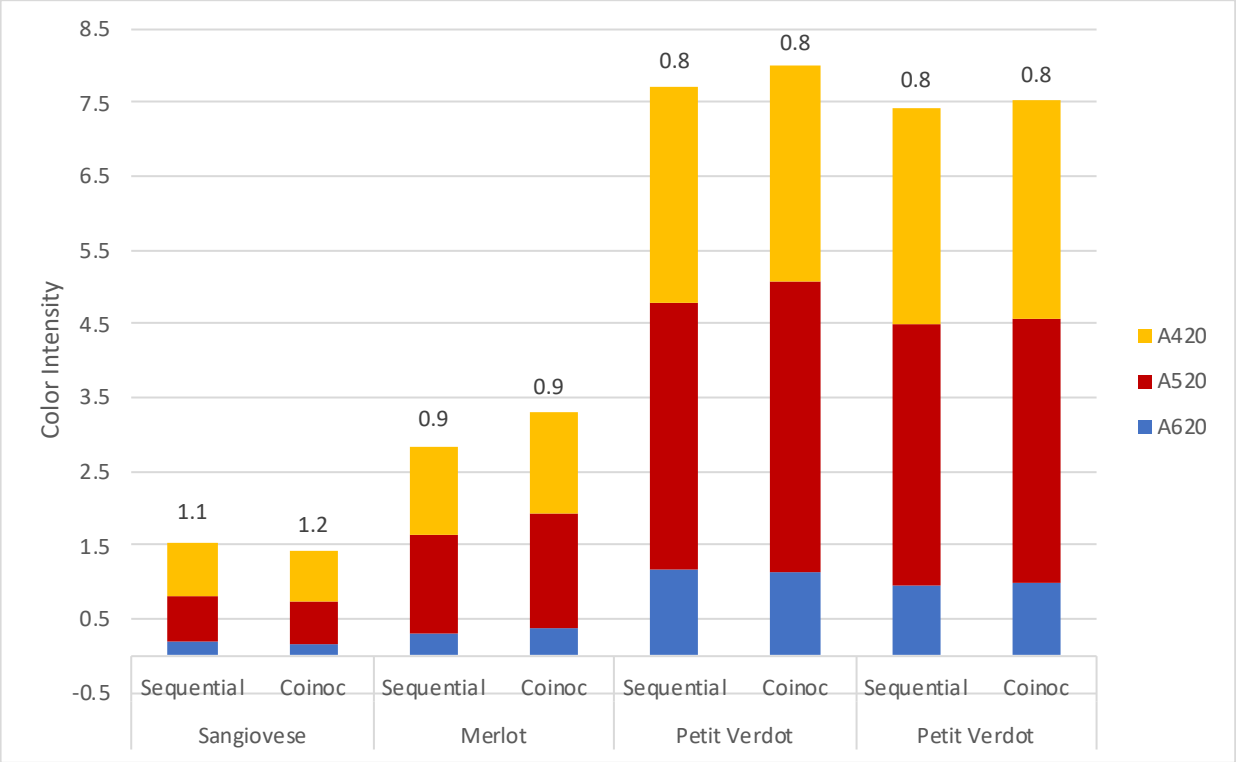
Each lot had slightly higher lactic acid and pH in the co-inoculated wine vs. the sequentially inoculated wine. There were no consistent differences in alcohol conversion rates or levels of acetic acid production.

Figure 3: Free and bound SO_2 for four treatment lots. The ratio of free:bound SO_2 is labeled on the endcaps.



Acetaldehyde is a byproduct of fermentation that is eventually consumed by *Saccharomyces* at the end of alcoholic fermentation and *Oenococcus* at the end of malolactic fermentation. Any acetaldehyde not consumed, or produced later by the oxidative conversion of ethanol, will be bound by SO_2. Acetaldehyde is the primary binder of SO_2 in the wine, so the amount of bound SO_2 gives a snapshot of overall acetaldehyde in the wine. Early completion of malolactic fermentation may lead to less acetaldehyde metabolism and, theoretically, shift the fraction of free:bound SO_2. That does not appear to be the case, here. There is not consistent pattern of SO_2 binding relative to the timing of malolactic fermentation (Figure 3).

Figure 4: Color Intensity for four treatment lots (ICV Labs Dec 2023). Hue (A420:A520) is labeled on the endcaps.



Color is a complex measure that is influenced by several factors including the concentration of pigments, the concentration of cofactors, the oxidative state of pigments, the pH and free SO_2 of the wine. These wines did not have identical pH and free SO2 values, so caution should be taken when interpreting color values. Co-inoculated wines had slightly higher color intensity in three of the four lots. For each, free SO2 values were very similar and pH values were slightly higher in the co-inoculated wine, which would be expected to decrease color intensity (Figure 4).

When wines were tasted by the winemaker and WRE Staff, there were no large or consistent differences in sensory characteristics between sequential and co-inoculated wines. These wines were not tasted at a sensory session.

Summary

The purpose of this experiment was to compare cellar efficiency, chemical and sensory outcomes of sequential vs. co-inoculation of malolactic fermentation in Ingleside red wines. In 2023, wines completed malolactic fermentation in a timely manner (by December) regardless of inoculation time, with no notable differences in wine chemistry or sensory characteristics between treatments. Though there were no differences in this year, co-inoculation may speed

up the process in other years with slower rate of malolactic fermentation. As long as fermentations are monitored carefully to avoid sluggish or stuck conditions (and consumption of residual sugar by *Oenococcus*), co-inoculation may be a good option to improve cellar efficiency at Ingleside.