Carbonic Maceration vs Traditional Fermentation in Merlot

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Summary

This study examined the impact of carbonic maceration on the chemical and sensory qualities of Merlot in comparison to traditional fermentation. For both fermentations, 20 liters of fermenting juice was added to the bottom of the fermentation vessels before adding destemmed grapes (for traditional fermentation) or whole cluster grapes (for carbonic maceration). The traditional fermentation was punched down twice daily until Brix were negative, and then pressed off. For carbonic maceration, maceration lasted for 5 days before being pressed off, with carbon dioxide being added twice daily. Free run and press fractions for both fermentations were combined. All other treatments were the same. As expected, carbonic maceration lowered all phenolic and color attributes in the wine. Most wine chemical parameters stayed the same, except that lactic acid was greatly increased in carbonic maceration. These results suggest that carbonic maceration reduces Body and Astringency compared to traditional fermentation. These results also suggest that the aroma in carbonic maceration changes greatly over a short period of time, as the Fruit Intensity and Ester Intensity of the carbonic maceration tended to more approach that of the traditional fermentation over time. Tasting order had a very large impact on descriptive analysis, so much of these results should be interpreted with care. Because the carbonic maceration wine is intended to be used as a blending component in red winemaking at this winery, in the future blending trials should be performed. Additionally, different carbonic maceration techniques should be employed, such as altering the temperature and time of carbonic maceration, or destemming berries at processing prior to maceration.

Introduction

Carbonic maceration produces wines that are often characterized by their aromatic richness, softness, and balance. Generally these wines are characterized by intense estery and fruity notes at first, which quickly decline over time. Carbonic maceration occurs when unbroken berries (either destemmed or whole cluster) are held in a tank for an extended period of time under an inert gas atmosphere (often carbon dioxide). It has been recommended that this time be from 5-8 days at 30-32°C, but this can vary widely depending on the style of wine desired. Glucose and malic acid is degraded inside the berry through anaerobic grape enzymatic reactions (intracellular fermentation). Malic acid can be degraded by up to half in this process, and about 1.5%-2% alcohol is formed. A concurrent yeast fermentation occurs in the free run juice, and often submerged grapes do not themselves undergo carbonic maceration (often because they are damaged from the weight of berries on top of them). Instead, the grapes which are only submerged in a carbon dioxide atmosphere themselves undergo maceration. Grapes are then pressed, and often the free run wine is kept separate from the press fraction juice in order to avoid lactic disease. This press fraction juice retains the carbonic maceration character, and must undergo a secondary yeast fermentation to complete alcoholic conversion of the sugars. Carbonic maceration wines generally have lower ethanol, titratable acidity, anthocyanins, and tannin, and have higher pH. They are also often characterized by higher succinic acid and succinic acid esters (Tesniere and Flanzy 2011). This study examined the impact of carbonic maceration on the chemical and sensory qualities of Merlot in comparison to traditional fermentation. The goal was to produce a carbonic maceration wine as a blending component to their red wine, in order to help fill out the middle of the wine.

Results and Discussion

As expected, carbonic maceration lowered all phenolic and color attributes in the wine. Most wine chemical parameters stayed the same, except that lactic acid was greatly increased in carbonic maceration.

Juice Chemistry

	Brix	pH
Juice Chemistry	23.1	3.90

Wine Chemistry

	Ethanol (%vol/vol)	Residual Sugar (g/L)	pH	TA (g/L)	Volatile Acidity (g/L)	Malic Acid (g/L)	Lactic Acid (g/L)	Total SO2 (ppm)	Free SO2 (ppm)	Molecular SO2 (ppm)
Traditional Fermentation	13.32	<1.0	3.74	4.16	0.52	<0.15	1.04	61	19	0.33
Carbonic Maceration	13.38	<1.0	3.79	4.02	0.43	<0.15	1.65	62	13	0.20

Lab Data from ICV from early March, 2017

Color Profile

	A420	A520	A620	Hue (420/520)	Intensity (420 + 520)	Intensity (420 + 520 + 620)
Traditional Fermentation	0.258	0.309	0.070	0.835	0.567	0.637
Carbonic Maceration	0.057	0.040	0.010	1.430	0.097	0.107
% Change	-78%	-87%	-86%	71%	-83%	-83%

Lab Data from ETS from early March, 2017

Phenolic Profile

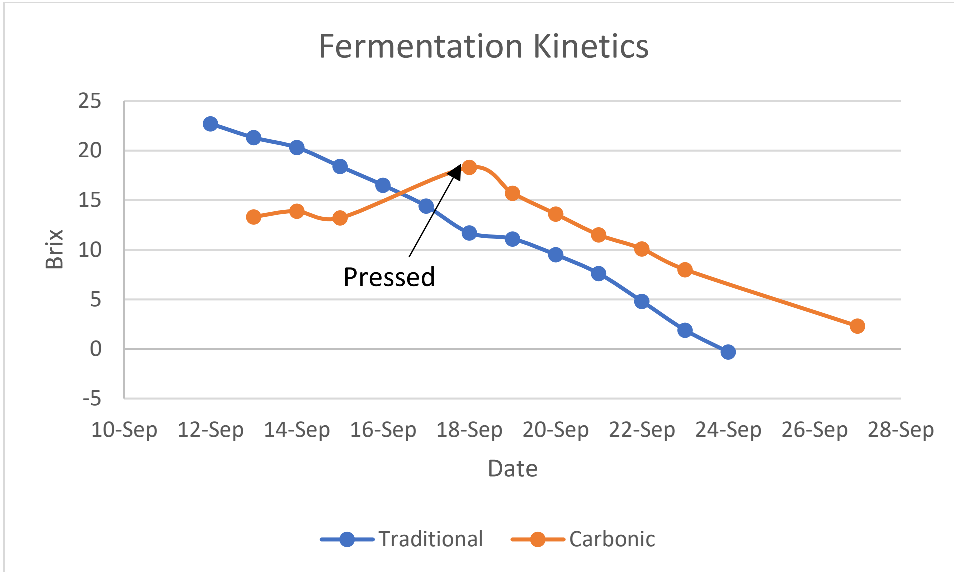
	Caffeic Acid (mg/L)	Caftaric Acid (mg/L)	Catechin (mg/L)	Epicatechin (mg/L)	Catechin: Epicatechin	Catechin: Tannin	Gallic Acid (mg/L)
Traditional Fermentation	3	11	11	10	1.1	0.03	15
Carbonic Maceration	2	3	1	1	1.0	0.01	3
% Change	-33%	-73%	-91%	-90%	-9%	-67%	-80%

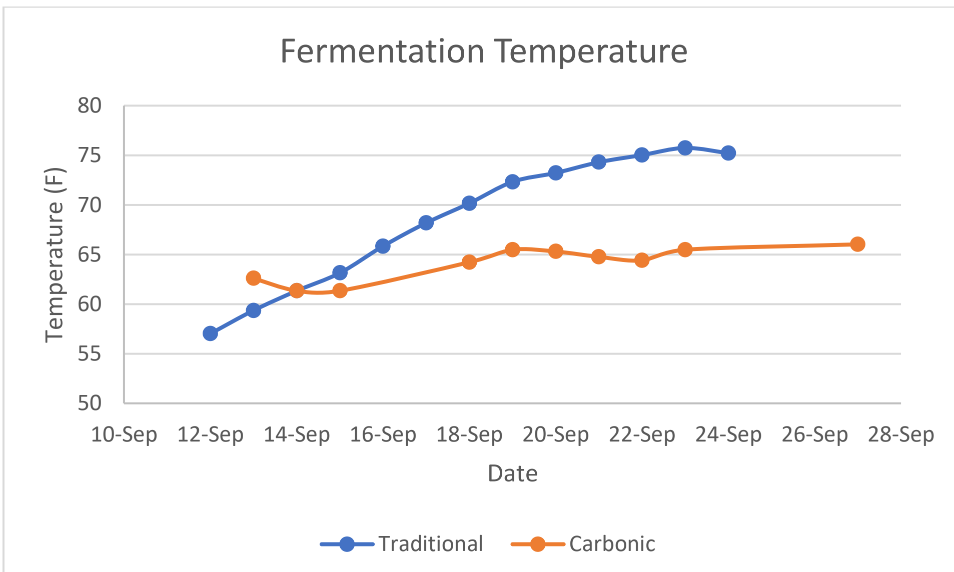
Lab Data from ETS from early March, 2017

Phenolic Profile

	Malvidin glucoside (mg/L)	Monomeric Anthocyanins (mg/L)	Polymeric Anthocyanins (mg/L)	Quercetin (mg/L)	Quercetin Glycosides (mg/L)	Tannin (mg/L)	Total Anthocyanins (mg/L)	Resveratrol (cis and trans) (mg/L)
Traditional Fermentation	94	138	22	1	22	412	160	1.9
Carbonic Maceration	15	16	4	<1	2	79	20	0.6
% Change	-84%	-88%	-82%		-91%	-81%	-88%	-68%

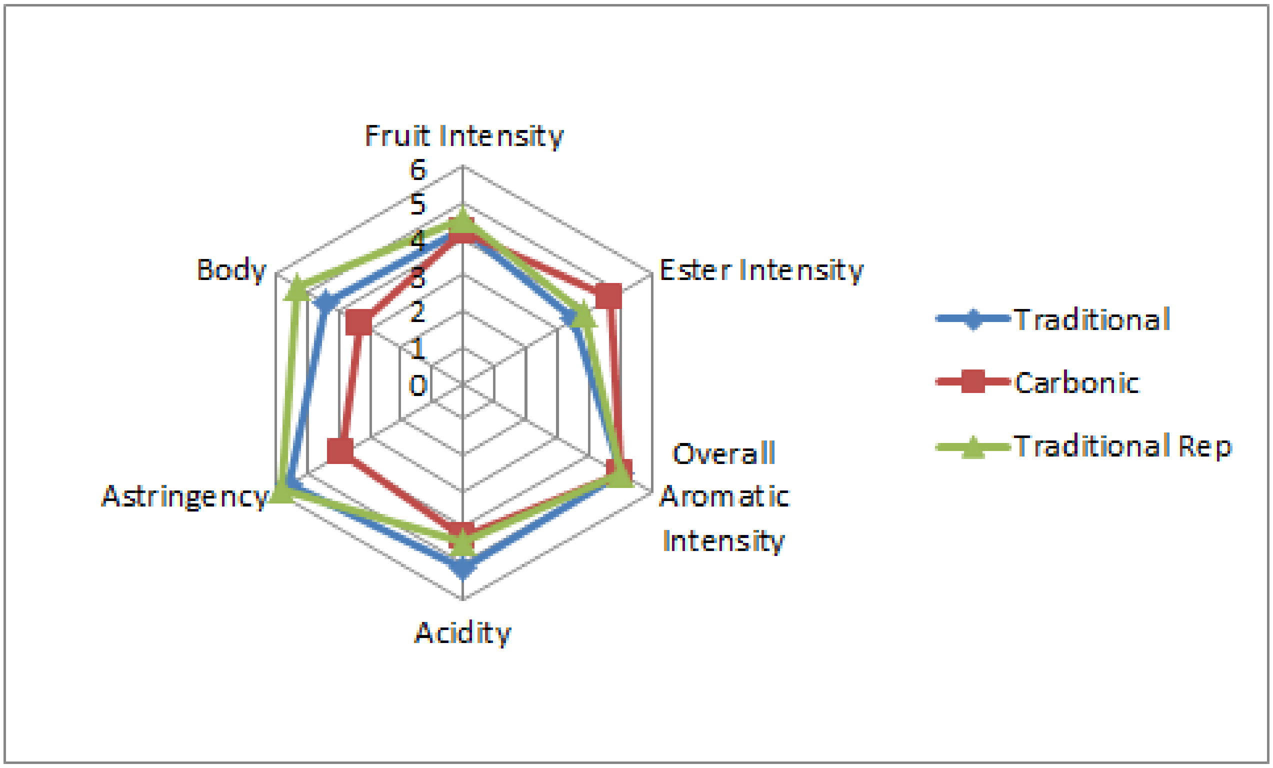
Lab Data from ETS from early March, 2017





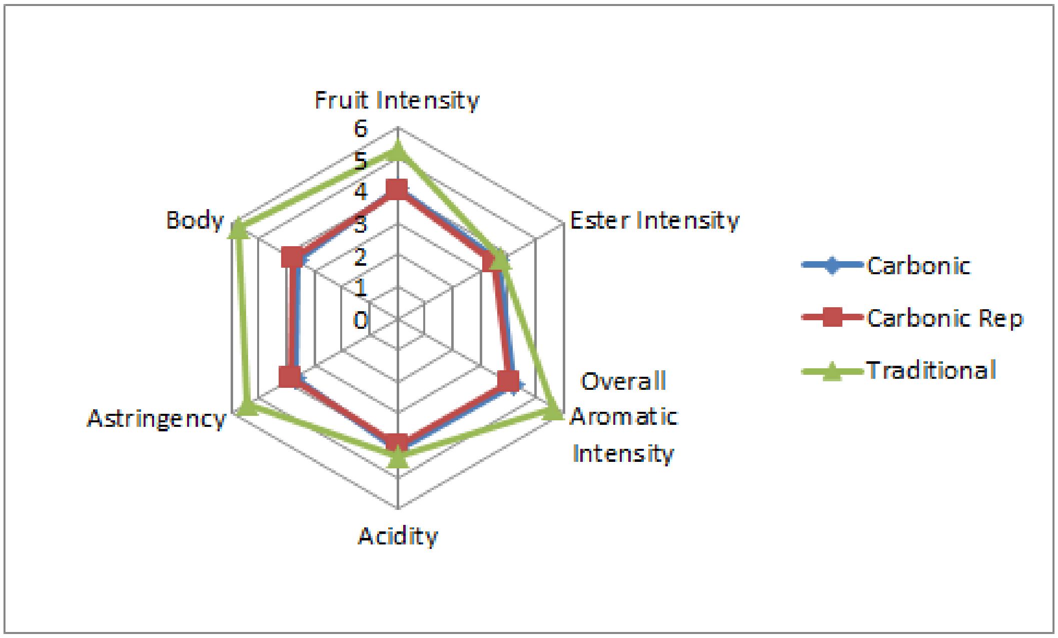
For the April 12 Tasting, in general there was a strong preference for the traditional fermentation practices over the carbonic maceration. There was a strong trend for traditional fermentation wines to have more Body than the carbonic maceration. The traditional fermentation tended to have higher Astringency and Acidity as well, and lower Ester Intensity. It is important to note that many people seemed to think that the traditional and traditional replicate wines were different, which may suggest that tasting the carbonic maceration wine between samples influenced perception.

	Traditional	Carbonic	No Preference	Total Votes
Preferred	71%	5%	24%	21



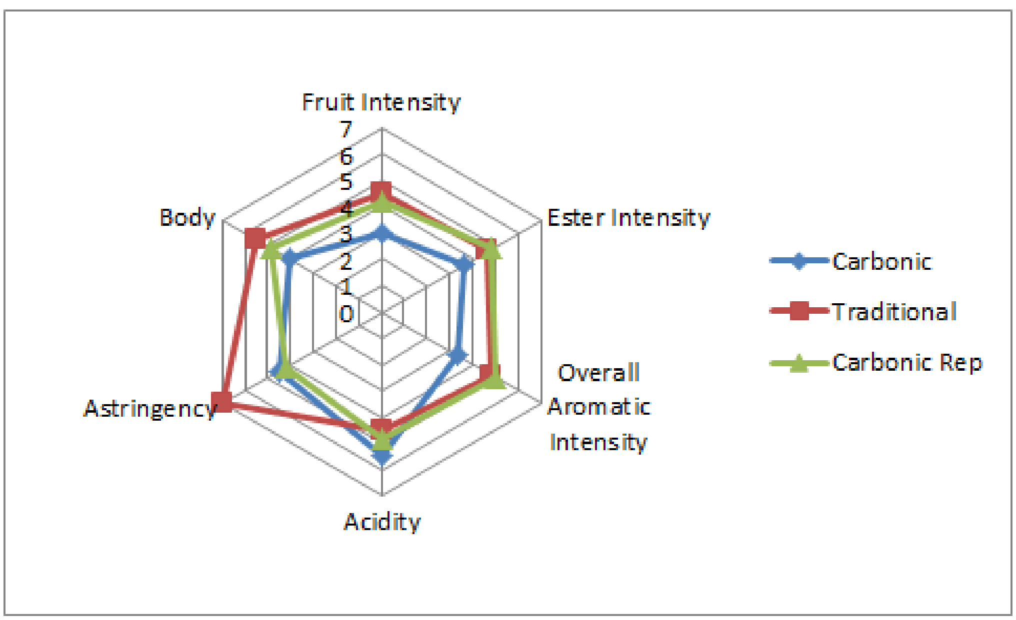
For the April 26 tasting, in general there was a strong preference to the traditional fermentation practices over the carbonic maceration. There was a strong trend for traditional fermentation wines to have more Body and Astringency than the carbonic maceration. The traditional fermentation tended to have higher Fruit Intensity and Overall Aromatic Intensity as well, and slightly higher acidity. At this tasting as well, there seemed to be strong impacts of tasting order on perception.

	Carbonic	Traditional	No Preference	Total Votes
Preference	20%	68%	12%	25



For descriptive analysis on May 17, no strong trends were found for the descriptors used in this study. In general, the wine made from traditional fermentation was perceived as having higher Astringency and Body, and was generally slightly higher in most attributes. In general, people tended to prefer the traditional fermentation, but this was a weak trend.

	Carbonic	Traditional	Total Votes
Preferred	33%	67%	6



These results suggest that carbonic maceration reduces Body and Astringency compared to traditional fermentation. These results also suggest that the aroma in carbonic maceration changes greatly over a short period of time, as the Fruit Intensity and Ester Intensity of the carbonic maceration tended to more approach that of the traditional fermentation over time. Tasting order had a very large impact on descriptive analysis, so much of these results should be interpreted with care. Because the carbonic maceration wine is intended to be used as a blending component in red winemaking at this winery, in the future blending trials should be performed. Additionally, different carbonic maceration techniques should be employed, such as altering the temperature and time of carbonic maceration, or destemming berries at processing prior to maceration.

Methods

Approximately 1.5 tons of Merlot was sourced from the same vineyard and processed into two separate tanks. Each tank received different treatments, discussed below.

Carbonic Maceration

This tank was first flushed and filled with carbon dioxide. 15 liters of fermenting juice from an already started Albariño fermentation was put into the bottom of the tank. This previous fermentation was inoculated with the same yeast strain as was used for the treatments in this project (EC1118). Then, around ¾ tons of whole cluster Merlot grapes were added to the tank and completely sealed. The tank had a pressure release valve that released excess carbon dioxide without allowing oxygen ingress.

Carbon dioxide was added to the tank twice daily for a period of 5 days (from loading to pressing). The pressure release valve released excess carbon dioxide once the headspace was filled with gas. The tank was not opened during this 5 day period. However, samples of free run juice were taken daily from the bottom valve of the tank for pH, Brix, temperature, and tasting. The goal was to leave the tank closed for as long as possible until maceration was deemed complete or if objectionable levels of ethyl acetate and acetic acid were formed.

After 5 days, the tank was opened and all free run juice was drawn off from the bottom valve of the tank and grapes/pomace were loaded into the press. The free run juice was transferred to a small tank for fermentation. EC1118 yeast was added at a rate of 10g/hL. Brix and temperature were taken daily during fermentation.

Once fermentation was complete (less than 2g/L residual sugar as measured by enzymatic assay), wine was racked to barrel for aging and samples were taken for basic chemical analysis (pH, TA, alcohol, malic acid, residual sugar, acetic acid). Free run and press fractions were combined.

"Traditional" Method Fermentation

15 liters of fermenting juice from an already started Albariño fermentation was put into the bottom of the macrobin. This previous fermentation was inoculated with the same yeast strain as was used for the treatments in this project (EC1118). ¾ tons of destemmed but not crushed grapes were loaded into the macrobin. 50 mg/L of sulfur dioxide was added at processing. EC1118 yeast was added at a rate of 15g/hL. Two punchdowns were done daily until Brix fell into negative numbers, after which the traditional fermentation was drained and pressed. No acid or sugar adjustment were made.

Free run and press fraction wine was taken from the macrobin before pressing and transferred to another tank for settling. Both wines were inoculated with ScottLabs VP41 malolactic bacteria. Once malolactic conversion was complete, 50 mg/L of sulfur dioxide was added and 2g/L tartaric acid was added to both wines.

This project was tasted on April 12, April 26, and May 17. In order to balance the data set to perform statistical analysis for descriptive analysis, any judge who had not fully completed the descriptive analysis ratings were removed. In order to then make the amount of judges between groups equivalent, one judge from group 2 was transferred to group 1. This resulted in a final data set of 3 groups, each with 7 judges (considered as replications within groups, and groups were considered as assessors). Data was analyzed using Panel Check V1.4.2. Because this is not a truly statistical set-up, any results which are found to be statistically significant ($p<0.05$) will be denoted as a "strong trend" or a "strong tendency," as opposed to general trends or tendencies. The statistical significance here will ignore any other significant effects or interactions which may confound the results (such as a statistically significant interaction of Judge x Wine confounding a significant result from Wine alone). The descriptors used in this study were Fruit Intensity, Ester Intensity (bubblegum, banana, etc), Overall Aromatic Intensity, Acidity, Astringency, and Body.

The same procedures for data analysis were used on the April 26 tasting. For the descriptive analysis in this tasting, each group had 8 judges, for a total of 24 judges.

The same procedures for data analysis were used on the May 17 tasting. In order to balance the data set for the descriptive analysis in this tasting, one judge was removed from Group 2 so that there were three groups, each with 2 judges.

References

Tesniere, C. and Flanzy, C. 2011. Carbonic maceration wines: Characteristics and winemaking process. In: *Advances in Food and Nutrition Research*, Vol 63. Ed. Ronald S. Jackson. Burlington: Academic Press. pp. 1-15.