

fermentation of red wines in the presence of oak

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INTRODUCTION

It is well known that wines aged in oak barrels retain color better than those stored in stainless steel. Barrels also remove vegetable character. As the cost of barrels increases, there is a growing interest in using other techniques to accomplish the same goals. Recently, innovative winemakers experimented with chips and oak powder during fermentation to maintain color extraction and remove green characters of wine.

In partnerships with Freemark Abbey and Beaulieu Vineyard, we investigated the effect of oak chips and oak powder on the red winemaking process.



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freemark abbey

THE WINE

Producer: Freemark Abbey
Year: 1999
Variety: Merlot
Vineyard: Red Barn Ranch, Napa
Crush Date: September 30, 1999

Harvest Data

Total Acidity: 0.64
Brix: 24.8
pH: 3.70
Solids: N/A

Days of Fermentation: 5-6 days

Wine Analysis as of 4/00

Alcohol: 13.6%
Total Acidity: 0.49 g/100 mL
Volatile Acidity: 0.041 g/100 mL
Free Sulfur Dioxide: 25 mg/L
Total Sulfur Dioxide: 45 mg/L
pH: 3.76

OAK DATA

Source: French oak
Wood Age: 24 month
Toast Level: Heavy

TRIAL EXECUTION

Sample Size: Half of one 40-pound bag per five tons of grapes at the hopper (4.6 lb/ton). Fermenters filled with 8.4-8.8 tons per fermenter.

THE TRIAL

Oak Chips Red Star Pasteur Red
Oak Chips Lalvin D254
No Chips Red Star Pasteur Red
No Chips Lalvin D254

beaulieu vineyard

EXPERIMENTAL DESIGN

The company provided four 40-pound bags of American Oak Powder to Beaulieu Vineyard for use in the trial. The Oak Powder was made of off-fall from barrel production. The wood was air-dried 24-months, and the fine chips were medium-toasted before being ground to powder. The Oak Powder was applied in the fermenter to 44-tons of Rutherford Cabernet Sauvignon and mixed in by means of circulation. This application was approximately half of the normal application rate, which is one 40-pound bag per five tons of grapes at the hopper. The treated tank was side-by-side with a control tank, fruit having been randomized at the crusher.

ASSESSMENT/DATA COLLECTION

The resulting wine from the treatment and control fermenter was kept separately in two puncheons. Color and tannin analyses was completed on the wines to detect and measure any difference between the treatments. The method of color analysis was a modified-UC Davis spectrophotometric protocol. Tannin results were reported in catechin equivalents by means of the Tannin Quantification Assay first published by A.E. Hagerman and L.G. Butler in the *Journal of Agricultural Food Chemistry* 26:809-812 (1978) and adapted by James Harbertson and Douglas Adams at UC Davis. The principle of this assay was based on the ability of tannins to precipitate proteins out of solution. Wine was mixed with the protein Bovine Serum Albumin (BSA), which acts as a carrier falling out of solution along with the tannin molecules. The tannin/BSA complex was recovered, washed, and dissolved in a detergent buffer. The amount of tannin in the sample was then measured by a color reaction after the addition of FeCl₃.

RESULTS

As of 12/21/00 the wines were dry and the malolactic fermentation was complete. The wines were held separately in drums. (Control – drum 26, Treatment – drum 18) Analysis of the wines as of 12/21/00:

	F/TSO ₂	pH	TiA	VA	Alc	Tannin (mg/L as Catechin equiv.)
Oak Powder	28/54	4.01	0.46	.031	13.73	149.8
Control	21/41	4.02	0.44	.033	14.14	152.1

Color Analysis of the wines as of 01/08/01:

	Total Phenols	Total Flavones	Browning	Visible Color	Color Intensity	Hue	Somers Monomeric anthos	Polymeric Color	Flavylum Color	Copig-mentation
Oak Powder	38.20	5.20	2.51	3.98	6.49	1.58	18.77	1.70	1.89	1.27
Control	36.90	5.23	2.38	3.61	5.99	1.51	19.50	1.57	1.56	1.58

OAK DATA

Source: American oak
Wood Age: 24 months
Toast Level: Medium. Toasted prior to re-sizing into powder.

TRIAL EXECUTION

Sample Size: One 40-pound bag per five tons of grapes at the hopper.

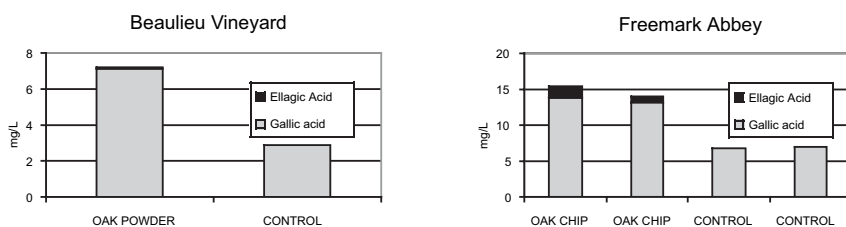
THE TRIAL

Oak Powder
Control

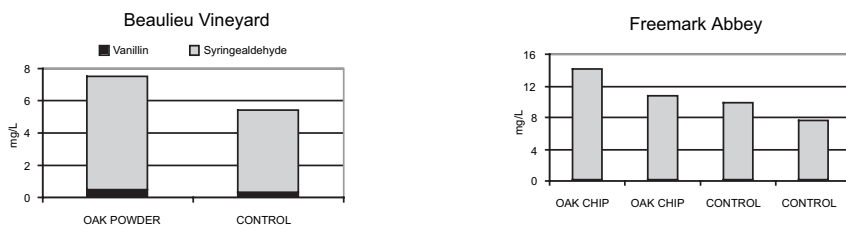
RESULTS AND DISCUSSION

The Beaulieu Vineyard wine was tasted in March. All panelists agreed that the wine fermented on oak was better than the one without. Their remarks on the oaked wine included “less vegetal,” “less astringent,” and “more fruit and smoothness.”

Chemical analysis was carried out on both the Beaulieu Vineyard and Freemark Abbey trials. The results proved the wine treated with oak chips contained slightly more oak compounds than the unoaked control (see Figure 1 through 6 below). A total increase of approximately 40% in compounds primarily associated with oak was observed. These findings are not surprising considering a fair amount of wood was used in this process. However, it has been shown in previous studies (see *Proceedings from the International Barrel Symposium 1999*) that oak effect diminishes with time, and this increase in oakiness may not be as apparent in six to nine months.



Figures 1 and 2: Tannin hydrolysis products in wine made with and without oak during crushing



Figures 3 and 4: Lignin degradation products in wine made with and without oak during crushing



Figures 5 and 6: Smoke compounds in wine made with and without oak during crushing

The wines were also tested for esters. These compounds enhance the fruitiness of the wine. They are formed primarily during the fermentation by yeast and may be further produced during maturation through reaction between acids and ethanol. Oak tannins are understood to enhance this reaction. Red wines crushed with oak chips appear fruitier. Production of esters either through esterification of acids and alcohol or some interaction of the solids with yeast was explored to explain this phenomena. However, the ester levels in all of these samples were similar, indicating no effect. This was further confirmed in laboratory scale fermentations with a series of oak dust additions.

The more likely explanation in the apparent lift in fruitiness is the reduction in vegetal aroma. Pyrazines are particularly noted for the vegetal aromas in Cabernet Sauvignon, the most prominent compound being 2-methoxy-3-isobutylpyrazine. Pyrazines are cyclic nitrogen-containing compounds. Pyridines are also cyclic nitrogen containing compounds, they have been implicated in the production of mousy, off-odors in wine. Some sulfur containing compounds have also been attributed to causing vegetal aromas in wine. For example, dimethyl sulfide has been described as having an asparagus or corn-like aroma at low levels. Wood, especially charcoaled wood, is a known absorber of sulfur compounds.

Unfortunately, the technology available at the time this analysis was carried out was not developed enough to detect the low levels of sulfur and nitrogen containing compounds. The ester analysis was done using solid phase micro extraction (SPME), a recent development in our laboratories. Advantages of SPME fibers over other concentration methods are (1) they require no solvent and thus are less prone to forming artifacts and (2) fibers are specific and selective; they selectively remove analytes of interest from interference. They are also fast, economical, and re-usable. A disadvantage of SPME is they have not been around long enough to discover all of their uses. Work has begun to determine the optimum fiber and working conditions for detecting nitrogen and sulfur containing compounds in wines.

There have been some hypotheses put forward that the use of chips in red wine fermentations can improve color stability. We have carried out several laboratory controlled experiments investigating this claim and have found no conclusive evidence of this to be true. Wine's absorbances were read at 420 and 520 nm. The 420 reading is an indication of brown color and 520 of red, the preferred color for young wines. In the first few days and several weeks following fermentation no clear trends in color measurements were found that could be linked to oak chip addition. After several weeks no difference in color readings were found at all. Further investigation and explanation of the oak action on wine phenolics is needed.

CONCLUSION

The addition of oak at the crusher in red wines can improve the flavor of the final wine by removing vegetal aromas, reducing astringency, and enhancing the fruit and smoothness. Our understanding on how this is accomplished is incomplete. It is unlikely to be due to increased esters levels through assisted esterification of alcohols and acids by oak tannins, because no increase in esters were found in these or other experiments. Additionally, the theory that oak tannins enhance the copigmentation of wine phenolics has not been supported by these results. Oak's ability to remove certain compounds, particularly off-odors, from wines and spirits could explain the increased fruitiness of wines treated in this way. Once the strong vegetal aromas are removed the fruit is more pronounced. Work is currently being carried out to prove this theory.