Do Vineyard Cultural Practices Improve Health Benefits in Wines?

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Abstract

Studies have suggested the importance of polyphenolic compounds as antioxidants and in prevention of degenerative diseases. Vineyard cultural practices that improve polyphenolic content of wine can be desirable. The effects of three cluster thinning or fruit removal treatments on anthocyanins, total phenolics, antioxidants, and resveratrol content of 'Chambourcin' wines were investigated. Cluster thinning increased the polyphenolic composition of wines as indicated by increases in anthocyanins, total phenolics, antioxidants and total resveratrol content. Strong positive correlation (r=0.97) was found between total phenolic content and antioxidant capacity suggesting the importance of total phenolics in affecting antioxidant capacity. It was concluded that cluster thinning produced 'Chambourcin' wines with increased potential health benefits.

Introduction

Epidemiological study suggested that moderate wine drinkers have reduced incidences of cardiovascular disease, a phenomenon known as the 'French Paradox' (Renaud and de Lorgeril 1992). Evidence points to the importance of antioxidants in delaying or reducing plague deposition of cardiovascular disease (Young and McEneny 2001). Studies showed that the non-alcoholic fraction of wines (polyphenolics) have potent antioxidant capacity and therefore polyphenolics were suggested as an explanation for the 'French Paradox' (Frankel et al. 1995). Of particular interest, trans-resveratrol, a specific polyphenol identified from grapes and grape products including wine, was found to be effective for the prevention of coronary heart disease (Wang et al. 2002) and was shown to have activity against certain classes of cancer (Jang et al. 1998). There are several forms of resveratrol (listed in order of the amount present in grape berries) which include trans and cis-resveratrol and their glycosides (Fig. 1). Identification of vineyard cultural practices that could improve polyphenolic content of wine will give wine grape growers and winemakers another quality improvement tool should this definition of quality (high antioxidant wine) becomes desirable in the near future. Indeed, the benefits of crop control on total phenolic and anthocyanin contents in Cabernet franc, Merlot and Pinot noir wines have been documented (Mazza et al. 1999). However, to our knowledge the effect of cluster thinning and yield level on the antioxidant capacity and specific polyphenols such as resveratrol in wine has yet to be determined. We hypothesized that low crop levels would increase polyphenols and antioxidants in wines. Two specific objectives evaluated the effect of cluster thinning on: 1) the total anthocyanins, total phenolic contents, and antioxidant capacity; and 2) the total resveratrol content (trans- cis-isomers and their glycosides) in 'Chambourcin' wines.

Materials and Methods

Finished wines of Chambourcin from vintages 2000, 2001, and 2002 were used in this study. Chambourcin wines were made from grapes harvested from three cluster-thinning treatments (10, 20, and 30 clusters/vine which corresponse to low, medium and high yield). Prior to fermentation, musts were chaptalized to similar °Brix levels. Fermentation was conducted at 29-32 ºC and wines were divided into three fermentation replicates.

Total anthocyanins, total phenolics and antioxidant capacity were measured spectrophotometrically after dilution and reaction with specific reagent. (Prajitna 2006)

Wine samples for resveratrol analysis were duplicately injected after passing through a 0.2 µm membrane filters. Resveratrol isomers in wine samples were separated and analyzed using a C18 column attached to a Waters 2695 HPLC unit and a Waters 2996 diode array module. Separation gradient and quantitation of resveratrol followed the procedure of Lamuela-Raventos and others (1995). Chromatogram is shown in **(Fig. 2)**. The regression equation of trans-resveratrol calibration was used for the calculation of all isomers assuming equal absorptivities of trans and cis isomers at 306 and 285 nm respectively.

ANOVA on cluster thinning was conducted using the GLM procedure (SAS 8.02, SAS Institute, Cary, North Carolina) and orthogonal contrasts were used to delineate linear or quadratic trend. Pearson correlations were obtained using the CORR procedure in SAS.

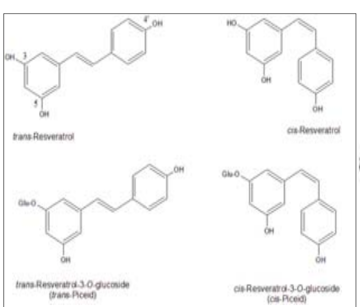

Figure 1. Resveratrol isomers and their glycosides

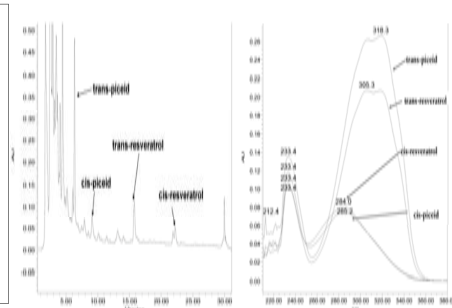

Figure 2. Chromatogram of resveratrol isomers and their spectrum

Results

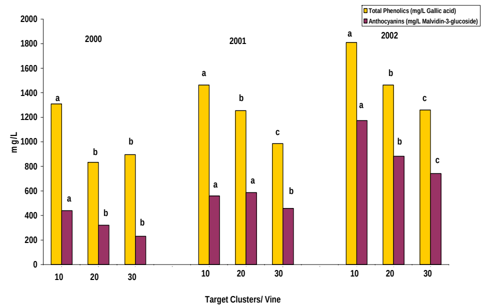

Figure 3. The effect of three levels of cluster thinning on total phenolic and anthocyanin content of 'Chambourcin' wines from three vintages

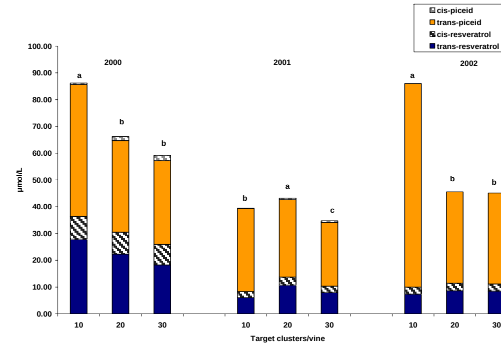

Figure 4. The effect of cluster thinning on resveratrol isomers of 'Chambourcin' Wine

Table 1. The effect of three cluster thinning levels on anthocyanins, total phenolics, and antioxidant capacity trends of 'Chambourcin' wines

Wine	target clusters	anthocyanins[a] (mg/L)	total phenolics[b] (mg/L)	FRAP[c] (mmol/L)	ABTS[d] (mmol/L)
Chambourcin 2000	10	441	1310	41.1	56.6
	20	321	833	28.3	40.9
	30	231	895	24.3	36.9
	linear[e]	**	**	***	***
	quadratic	ns	**	***	***
Chambourcin 2001	10	560	1462	36.3	49.6
	20	587	1254	33.8	48.4
	30	458	986	29	42.5
	linear	***	***	***	***
	quadratic	**	ns	ns	***
Chambourcin 2002	10	1173	1809	44.9	61.5
	20	883	1462	36.6	51
	30	741	1260	32.5	46.2
	linear	***	***	***	***
	quadratic	**	ns	*	**

[a] Absorbance determination at 520nm. Results expressed as malvidin-3-glucoside equivalents.
[b] Total phenolic levels by Folin-Ciocalteu reagent. Results expressed as gallic acid equivalents.
[c] FRAP(Ferric Reducing Ability of Plasma) antioxidant capacity assay. Results expressed as mmol trolox /L of wine.
[d] ABTS(2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) antioxidant capacity assay. Results expressed as mmol trolox/L of wine.
[e] Orthogonal contrasts – ns = not significant; * = *P*<0.5; ** = *P*<0.01; *** = *P*<0.001.

Table 2. Relationships among phenolic components and antioxidant capacity of 'Chambourcin' wines

traits	correlation coefficients[a] Chambourcin[b]
total phenolics vs total anthocyanins	+ 0.94 ***
total phenolics vs total resveratrol	+ 0.83 **
total anthocyanins vs total resveratrol	+ 0.66 ns
FRAP vs total phenolics	+ 0.97 ***
FRAP vs total resveratrol	+ 0.90 ***
FRAP vs ABTS	+ 0.99 ***

[a] Coefficient significance – ns = not significant; * = *P*<05; ** = *P*<0.01; *** = *P*<0.001.
[b] Composite of the 2000, 2001 and 2002 vintages at three cluster thinning treatments.

Discussion & Conclusions

- Cluster thinning improved wine anthocyanins and total phenolic content of 'Chambourcin' wines in all years which resulted in wines with more intense color **(Fig. 3 & Table 1)**.
- Wines made from low clusters treatment contain on average 40% more antioxidant compared to high clusters ones **(Table 1)**. Strong positive correlation was found between total phenolics and antioxidant capacity **(Table 2)** indicating the influence of phenolic content in affecting antioxidant capacity which has been previously reported (Burns et al. 2000).
- Cluster thinning improved trans-piceid (glycoside of trans-resveratrol) in two years **(Fig. 4)**. However, the effect of crop removal on trans and cis-resveratrol did not show consistent trend.
- We speculate that cluster thinning may be affecting polyphenolic contents in wines directly by altering the source and sink ratio and as such may increase the substrate levels necessary for polyphenol synthesis or indirectly by enhancing wine grape maturity.
- In Ohio, the limitation of cool climate and short season make cluster thinning of red cultivars such as 'Chambourcin' a "must" to improve quality.
- Cluster thinning not only improves flavor quality but also improves the nutrition health quality of grapes and wines.

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