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Effects of Grape Skins and Seeds on the Composition and Quality of Muscadine Wines

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ABSTRACT

The contributions of grape skins and seeds to the composition and quality of muscadine wines, when these are present during a partial fermentation process, were determined. The presence of the grape components affected total and volatile acidity, total phenol and volatile ester concentrations, as well as wine color. The quality of white wine made from partially fermented must in the presence of grape skins and seeds was lower than that in which the seeds were absent during this process, as well as that which was produced from fresh grape juice. Grape seeds had no significant effect on the sensory scores for red wines.

INTRODUCTION

Muscadine (*Vitis rotundifolia* Michx.) grapes are widely grown in the southeastern United States. A major commercial outlet for these grapes is wine production, and enological interest in muscadine grape cultivars has developed largely over the last decade. Many reports dealing with the qualities of muscadine wines, and how these are affected by variations in cultivars, as well as some grape parameters are now available (Ballinger *et al.*, 1974; Carroll, 1984; Carroll *et al.*, 1975, 1978; Nesbitt *et al.*, 1974; Radvanyi *et al.*, 1980).

Some differences between grapes in the muscadine group and other grape

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cultivars include their existence in small clusters on vines, and their characteristic thick leathery appearing skins. Individual berries are usually large and round. The pulp is also very tough, although this is not localized around the seeds as found in *Vitis labrusca* grapes. The number of seeds per berry lies between 1·8 and 3·4 (Armstrong *et al.*, 1934). The dark grapes are usually deeply pigmented with a combination of 3,5-diglucosides of delphinidin, petunidin, cyanidin, malvidin and peonidin (Ballinger *et al.*, 1973, 1974; Nesbitt *et al.*, 1974; Flora, 1978). The methods that are commonly used for wine production from muscadine grapes are similar to those utilized for other grape cultivars with minor variations. For red wines, it is customary to carry out a partial fermentation on pomace and seed for a period of 3–5 days after the grapes have been crushed. The juice is then separated and/or expressed and final fermentation is carried out. The traditional method for making white muscadine wines is similar to that used for red wine production. The advantages of this method include easier pressing, greater yield of juice and wine and consequently lower cost per gallon of wine (Bates *et al.*, 1980). The principal disadvantage is that the long contact period with grape seeds and skins results in the extraction of various compounds which appear to lower wine quality. For this reason most wine makers no longer do a preliminary fermentation on grape skins and seeds when white muscadine wines are made. The process is still, however, commonly used for red wines, because of the need to extract pigments from grape skins.

The study was designed to investigate the contributions of muscadine grape skins and seeds to the composition and quality of wines, when these grape components are present in the preliminary fermentation process.

MATERIALS AND METHODS

Fruits of Dixie and Noble cultivars of muscadine grapes were harvested at maturity and crushed in batches of 35 kg on a fruit deseeder (Elliot Manufacturing Co., Fresno, CA). Over 90% of the seeds were separated from the rest of the fruit with the aid of this seeder. The musts were then treated with potassium metabisulfite (100 ppm). Juice from the first set of crushed Dixie grapes was pressed after 5 days, during which the juice maintained contact with grape skins in one, and the skins with the seeds added back in the other, respectively. Red wines were produced from two sets of crushed Noble grapes treated in a similar manner to the latter two Dixie batches. Fermentation of musts (21° Brix), carried out with pure *Saccharomyces cerevisiae* (Montrachet strain) at 18°C, was complete in less than 4 weeks. The wines were racked at this time and left to settle, after which they were racked a second time. The glass carboys that contained wine samples were than transferred to cold storage (0°C) for about 6 weeks to precipitate insoluble potassium bitartrate crystals. They were later filtered through a membrane filter (0·45 μ), bottled and stored at about 13°C.

Wine samples were analyzed for the following: pH, using a pH meter with a combined glass-calomel electrode; total titratable acidity as tartaric acid, titration with sodium hydroxide (0·1 M); volatile acidity, using the Cash distillation apparatus (Vine, 1981), total phenols by the Folin-Ciocalteu method (Amerine & Ough, 1980); total volatile esters (Amerine & Ough, 1980) and per cent alcohol with the aid of an ebuliometer. Color differences were determined on a Perkin-Elmer Lambda 3B spectrophotometer equipped with an integrating sphere and a data station. Transmittance values from scans between 780 and 380 nm at 1 nm intervals were used to obtain chromaticity coordinates, luminance (L) and tristimulus (a and b) values using the CIE standard source C, with the aid of a color program (MacAdam, 1981). Optical densities of wine samples at 420 and 520 nm were also obtained using this equipment. Sensory evaluations were made on the wines by a panel of 12 judges experienced in evaluating muscadine wines. The wine samples were coded with different two-digit random numbers, and were presented to the judges at a temperature of about 10°. Evaluations were based on a 20-point score card developed by Klenk (Amerine & Roessler, 1976).

Each treatment during the wine making process was replicated, and the reported results represent the mean from duplicate determinations of each treatment in most cases. Statistical analysis of data was carried out using the Student t-distribution.

RESULTS AND DISCUSSION

The chemical characteristics of the grapes used (Table 1) are consistent with those previously observed on ripe muscadine berries (Carroll *et al.*, 1978; Radvanyi *et al.*, 1980; Flora, 1988). The juice yield from the Dixie grapes that were pressed immediately after crushing was noticably lower than that from those that were pressed after an initial fermentation period (Table 2). Significant changes were not observed in the titratable acidity values as a result of the different processing methods. The prefermentation process resulted in higher volatile acidity and extract values, both in the presence and absence of grape seeds. The amounts of volatile acids present in all the wine samples were well within the established federal limits (US Internal Revenue Service, 1961).

Preliminary fermentation in the presence of grape skins caused an

TABLE 1
Harvest Parameters of Muscadine Grape Cultivars used for Wine Production

Cultivar	*pH*	°*Brix*	*Total acidity, as tartric* (%)
Dixie	3·20	13·6	0·63
Noble	2·95	14·1	0·68

increase in the amount of total phenols present in Dixie wines, and the presence of seeds during this period resulted in higher phenolic concentrations in both Dixie and Noble wines. Phenolic compounds are important for reasons such as imparting astringent taste, possible cause of pungent odor and bitterness and furnishing color in wines. They are also a

TABLE 2
Characteristics of Wine Produced from Dixie and Noble Grapes. Values in Each Row for both Dixie and Noble Cultivars, Without the Same Letters, are Significantly Different ($P < 0{\cdot}05$)

Determination	*Dixie*[a]	*Dixie*[b]	*Dixie*[c]	*Noble*[a]	*Noble*[b]
Must yield ($l\,kg^{-1}$)	0·32*a*	0·32*a*	0·26*b*	0·34*a*	0·35*a*
pH	2·92*a*	2·93*a*	2·95*a*	2·47*b*	2·75*b*
% alcohol	11·8*a*	11·8*a*	12·2*a*	12·5*a*	12·9*a*
Total acidity as tartraic ($g\,100\,ml^{-1}$)	0·08*a*	0·78*a*	0·83*a*	0·78*a*	0·78*a*
Volatile acidity ($g\,100\,ml^{-1}$)	0·030*a*	0·030*a*	0·012*b*	0·024*a*	0·024*a*
Extract ($g\,100\,ml^{-1}$)	2·5*a*	2·8*a*	2·0*b*	2·6*a*	3·0*a*
Total phenols ($mg\,100\,ml^{-1}$)	61*a*	108*b*	50*ac*	123*d*	158*e*
Total volatile esters ($mg\,l^{-1}$)	140*a*	110*b*	74*c*	65*c*	116*b*
Color					
L	74·3*a*	74·3*a*	84·2*b*	52·2*c*	49·5*d*
a	−2·2*a*	−4·7*b*	−1·7*a*	13·5*c*	12·9*c*
b	18·4*a*	19·3*a*	10·9*b*	4·7*c*	5·1*c*
A_{420}	0·46*a*	0·52*a*	0·23*b*	2·44*c*	3·36*d*
A_{540}/A_{420}	—	—	—	1·20*a*	1·00*b*
Sensory Scores					
Appearance	2·93*a*	2·67*a*	3·33*a*	3·53*a*	3·47*a*
Odor	2·00*a*	2·00*a*	2·20*a*	2·47*a*	2·40*a*
Taste	9·47*a*	5·95*b*	9·05*a*	9·51*a*	9·76*a*
Overall rating	14·17*a*	10·23*b*	14·00*a*	15·34*a*	15·48*a*

[a] Wine made from partially fermented must in the presence of grape skins.
[b] Wine made from partially fermented must in the presence of grape skins and seeds.
[c] Wine made from must obtained from freshly crushed grapes.

reservoir for oxygen reduction and a source of browning substrate. High molecular weight phenolic compounds such as tannins are mostly found in grape skins and are largely responsible for wine astringency. The low molecular weight phenolics, some of which are precursors to bitterness, are distributed in the grape skins and seeds. The higher levels of phenolic compounds observed in wines made from partially fermented musts result from the extraction of anthocyanins from grape skins. Contributions from the seeds are likely to be in the form of low molecular weight phenol compounds such as flavanones (Amerine & Ough, 1980). The implications of the different levels of phenols obtained in these wines, especially red wines, for their long-term stability are not yet clear. Compounds such as tannins are continually degrading and reforming to produce new compounds with different taste characteristics. They can also react slowly with anthocyanins to form insoluble polymers that eventually precipitate in wines (Berg & Akiyoshi, 1975; Somers & Evans, 1977). This might be responsible in part for the lack of pigment stability which is often observed in Noble wines, approximately one year after bottling.

The effect of the presence of seeds, during partial fermentation, on the amount of volatile esters present in the Noble wines, was an increase. In the Dixie wines, however, a reverse effect was observed. The amount of volatile esters present in the wine from juice that was pressed off freshly crushed grapes was lower than that obtained for both the wine produced from partially fermented must in the presence of both grape skins and seeds and that in which the seeds were absent. Most of the esters present in wines are usually formed during the alcoholic fermentation by yeast and particularly by acetic acid and lactic acid bacteria, and their concentration slowly increases with storage. The relatively high volatile ester concentrations in the white wine made from partially fermented must in the absence of grape seeds is unlikely to result from bacterial action alone. The amounts of volatile esters in these wines were insensitive to the concentrations of volatile acids, as would be expected if the increased ester concentrations are due to bacterial action (Peynaud, 1956). Their concentrations in these wines have been influenced by the amount of solids present during the prefermentation process. The solid contents of musts was shown by Singleton *et al.* (1975) and Williams *et al.* (1978) to be related to the amount of volatile esters present in wines.

Wine colors, as indicated by their luminance and tristimulus values, were affected by the different processing methods. Preliminary fermentation of Dixie grapes in the presence of seeds resulted in a tristimulus '*a*' value that was relatively higher than that obtained from a prefermentation process in the absence of seeds and the wine that was produced from fresh Dixie juice. Dixie wine that was produced by the latter process also had a significantly lower tristimulus '*b*' value. The '*L*' value was, however, higher for this Dixie wine than those produced through the initial fermentation process. The differences between tristimulus values of the red wines were not significant at the 0·5 level, but the presence of grape seeds during fermentation caused a significantly lower '*L*' value. The effect of grape seeds on the ratio of absorbance at 540 nm to that at 420 nm, which is usually indicative of hue changes in red wines, was a decrease. In sensory evaluations, no significant differences were reported in either odor or appearance of the wines. The same was true for the overall rating of Dixie wines. Some members of the panel reported an unacceptable level of bitter aftertaste in the wine that was fermented in the presence of grape seeds. The presence of seeds during the fermentation of Noble wines, however, did not affect the wine quality significantly.

It is evident from this study that partial fermentation for muscadine must, as well as the presence of grape seeds during this process, have considerable effects on the composition of these wines. The presence of seeds during this process also impacts negatively on the quality of its white wines. While the difference in the quality of Dixie wine produced from its fresh juice was not significantly different from that in which the skins were absent during fermentation, the relatively high solids content of the must in the latter process can eventually influence the levels of higher alcohols, volatile esters and hydrogen sulfide. These compounds can be detrimental to wine quality when they are present in large quantities (Singleton *et al.*, 1975; Groat & Ough, 1978). Factors, such as convenience and economic implications of seed removal prior to the fermentation of red wines, also make this process unattractive, especially since the sensory evaluation of wines produced by this method did not indicate a significant improvement in their quality.

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