STUDIES WITH CONTROLLED FERMENTATIONS. VII. EFFECT OF ANTE-FERMENTATION BLENDING OF RED MUST AND WHITE JUICE ON COLOR, TANNINS, AND QUALITY OF CABERNET SAUVIGNON WINE[1]

C. S. OUGH AND M. A. AMERINE[2]

The problem of extracting color pigments from red grape skins was studied by Berg and Akiyoshi (7), who pointed out that most of the pigments are found in the cell vacuole surrounded by a semipermeable cytoplasmic membrane and that the pigments will not pass through this membrance unless the cell is injured or killed. Various factors that affect the membrane permeability have been investigated. Amerine and DeMattei (3) found that asphyxiation of the cells increased color yield slightly. Berg and Marsh (8), using heat to stop cellular activity, increased color yield but also decreased wine quality. Treatment of red must with alcohol prior to fermentation has been shown by Berg and Akiyoshi (6) to increase color yield for port-type wines, but, again, quality was impaired. Amerine (1) and Ough and Amerine (9) showed that the temperature of fermentation is an important factor in both the color yield and quality of red wine fermentations. The contact time of the extracting juice with the skins (4) has been shown to be a small but significant factor in the highly pigmented varieties.

In spite of the wealth of knowledge pertaining to color extraction, the practice of good wine making has not changed as far as color extraction is concerned. The foregoing methods for increasing color yield have, in general, one or two defects: they either decrease wine quality and/or they are too expensive.

One aspect of color extraction that has not been investigated in detail is the effect of blending white must with unpressed red must to determine if the greater volume of liquid would increase the amount of pigment extracted from the skins. Since most highly colored red wine grape varieties are blended after fermentation, an experiment was done to compare wines made by blending white must with red unpressed must (ante-fermentation blend) to wines made by blending the finished white wine with the finished red wine (post-fermentation blend). As well as determining if there was any color or quality difference between the two methods of blending, an effort was made to find what effects the dilution had on rate of color extraction, distribution of the color pigments between the skins and liquid, and the percentage of pigment lost during fermentation and short-term cellar handling.

METHODS AND MATERIALS

Grapes. All grapes used were grown in the University vineyards at Oakville or Davis, California. The Cabernet Sauvignon grapes were harvested at Oakville on September 26, 1961, for the first experiment, and on October 4, 1961, for the second experiment. The juice used in the first experiment was of Grenache from Oakville, picked on September 26. White juice blended in the second experiment was from a mixture of grapes from the Davis vineyard.

Blending. Blending of the juice and must prior to fermentation was on a percent-volume basis. The first experiment had blends of 0, 10, 20, 40, 60, 80, and 100 per cent Sauvignon, and the second blends from 0 to 100 per cent Cabernet Sauvignon

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[2]Associate Specialist and Enologist, respectively, Dept. of Viticulture and Enology, University of California, Davis, California.

at 10 per cent intervals. The Cabernet Sauvignon must was first mixed thoroughly, after which small amounts were transferred to the various tanks until the given volumes were reached. Each tank received a minimum of 10 increments of must to assure uniform composition among the lots. The tanks were then brought to volume with juice.

For the first experiment the post-fermentation blends were made immediately following fermentation. The volume of the blended lots was adjusted to the same as that before fermentation. In the second experiment the volumes of extracted juice were likewise kept constant in the before- and after-fermentation blends. In the second experiment, the post-fermentation blends were made after the wines were clarified and filtered (approximately 4 months after completion of fermentation).

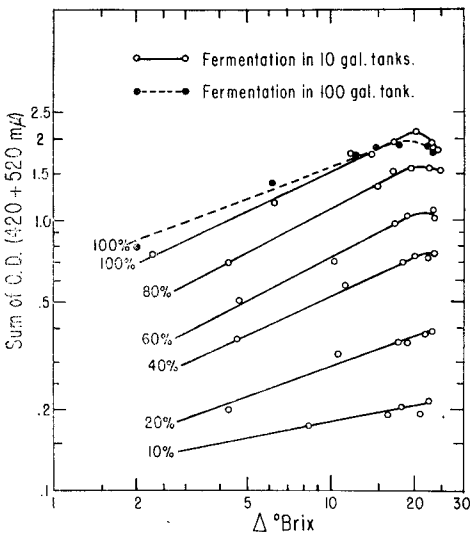

Figure 1. Rate of color extraction for various blends (percentage of Cabernet Sauvignon in the blends designated in figure) of Cabernet Sauvignon and Grenache must (pressed immediately) expressed as log color (sum O.D. at 420 and 520 mμ) per log change in degree Brix over a Brix change of the last 20 degrees. (Similarity of slope of the lines indicates likeness of rates.)

Sampling. During the first experiment fermentation samples were taken once or twice daily. Degrees Brix were recorded, and the samples were fortified to 20 per cent alcohol by volume and stored at 32°F for later analyses.

In the second experiment, 1 gallon of the original Cabernet Sauvignon must was extracted with 1 gallon of 190 proof alcohol for 48 hours and screened off, and the extract stored. The pressed pomace of the various blends was reconstituted to the original Cabernet Sauvignon must volume with water, and 1 gallon of this was extracted with 1 gallon of 190 proof alcohol, stored for 48 hours, and screened off. The extracts were settled, racked, and stored at 45°F.

Chemical and sensory analyses. Chemical analysis was done according to methods of Amerine (2). Optical-density measurement for color evaluation was made at 420 and 520 mμ as suggested by Ough *et al.* (10). Sensory examinations were carried out by an expert panel using a quality scoring system of 1 to 20 points (5). Quality scores were analyzed statistically with an analysis of variance.

RESULTS AND DISCUSSION

Color samples were taken daily during the first experiment on the blends of Cabernet Sauvignon must with Grenache juice. Figure 1 plots the color values against the change in °Brix. This type of plot will not give as good a straight-line relation, as will a similar plot of alcohol versus color; however, over the range of change in °Brix between 2 and 20, a good linear relationship holds. This plot indicates that color extraction is complete after a drop of about 20° Brix. The slopes of the lines are nearly equal, and even with only the few points available in the lower range in °Brix area, the rate of color extraction does not appear to vary appreciably among blends. Also, Cabernet Sauvignon grape pigments are not easily released, considering that Berg and Akiyoshi (7) have shown that Zinfandel and Carignane pigments reach maximum concentration in fermenting must at 3 to 6 per cent alcohol. The rate of pigment release must be considered to be a primary function of the alcohol concen-

tration as reported by Berg and Akiyoshi (7).

The total color in the finished wine is of primary interest. Color determinations were made on the 2 series of blends. Figure 2 plots the color versus the blend percentages in the second blend series. The plot for the wine of the must blend prior to fermentation is nearly linear, as expected. However, the line of the wines blended from equivalent amounts of 100 per cent Cabernet Sauvignon wine shows a nonlinear shape, and, in general, less color was found. Figure 2 also compares the percentage of the post-fermentation blends with that of ante-fermentation blends. There appears to be large color gains, but, as is shown in a model system (Figure 3), this would be expected and is accountable by the fact that the equivalent amount of 100 per cent Cabernet Sauvignon used in each post-fermentation blend was the amount of 100 per cent Cabernet Sauvignon that could be pressed in a normal operation from the fermented pomace (normal to the extent of the amount removed by pressing in a basket press under 40 psi face pressure). Hence, it is seen from the model system that the color differences in the percentage blends can be explained to a large extent by the volume relationships. More simply, the greater the percentage of skins to the overall must volume the greater the percentage of liquid that will be entrained in the pressed pomace.

Figure 4 shows a similar relation of tannins to per cent Cabernet Sauvignon in the blend, and the same reasoning will hold for the differences between the two lines of the plot.

The first blend series showed relations with color and tannin similar to those shown above for the second blend series.

To find the disposition of the color, a color balance was made. The Cabernet

TABLE I

Color Density Distribution

Between Skins and Wine of Several Cabernet Sauvignon Blends[a]

Cabernet in blend (%)	Color present[b]			Color distribution between wine and skins		Accountable color[c] total (%)
	Skins	Wine	Total	Skins (%)	Wine (%)	
10	0.97	2.92	3.89	24.9	75.1	25.2
20	2.64	3.75	6.39	41.3	58.7	41.1
30	3.28	3.14	6.42	51.0	49.0	41.2
40	4.00	2.83	6.83	58.6	41.4	43.9
50	4.71	3.13	7.84	60.2	39.8	50.3
60	3.76	2.95	6.71	56.0	44.0	43.1
70	3.50	2.60	6.11	57.2	42.8	39.3
80	4.18	2.62	6.80	61.4	38.6	43.7
90	3.68	2.41	6.29	58.5	41.5	40.5
100	3.51	2.57	6.08	57.8	42.2	39.1
mean value						40.7

[a]On basis of extracted wine and pressed pomace.

[b]Color reported as the sum of the optical densities at 420 and 520 mμ and adjusted to the basis of O.D. per 0.7 gal. of extracted juice per gal. of Cabernet must.

[c]Accountable color is the percentage of the total color found when compared with the color present in an equivalent amount of unfermented Cabernet must (15.55).

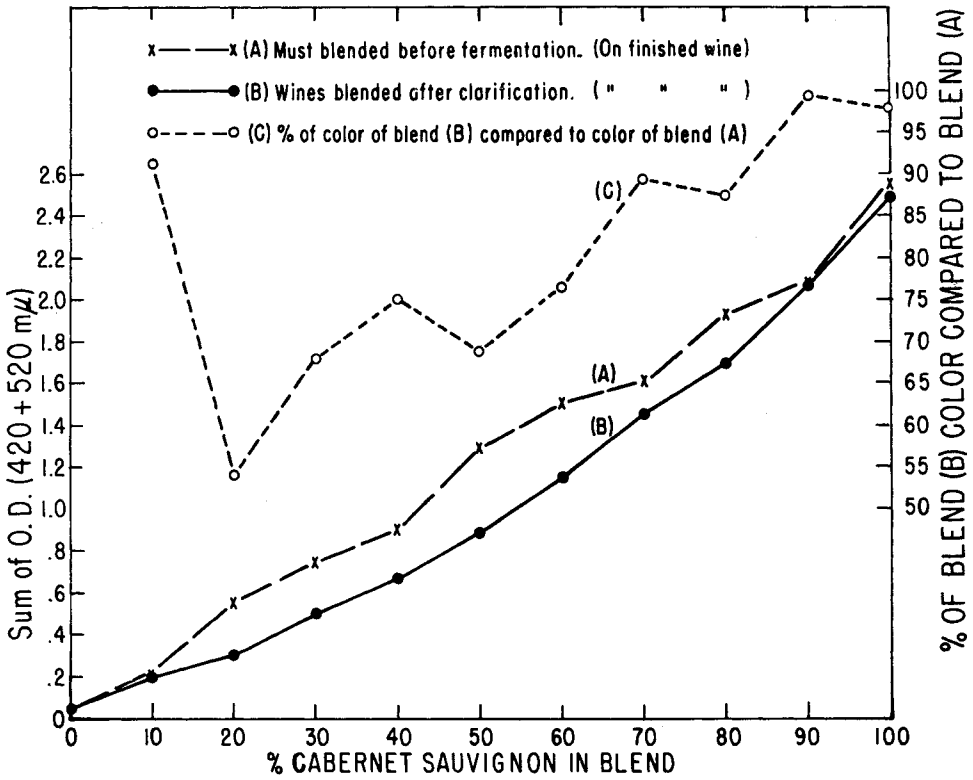

Figure 2. Total color of blend wines by two methods of blending and the percentage of blend B color as compared to blend A color. Blend A was based on the volume of wines extractable from a given initial amount of the Cabernet Sauvignon must.

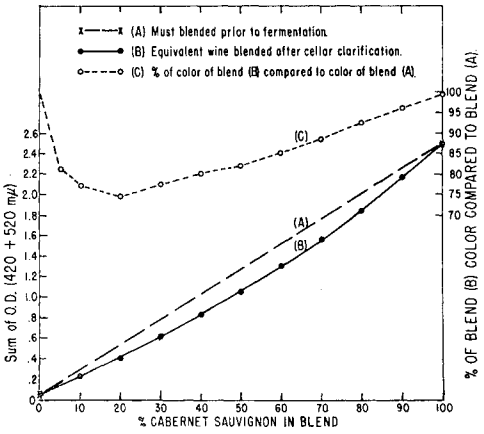

Figure 3. A model of the expected color and the color percentage of one blend method as compared to the other (based on volume considerations of the two methods of blending).

Sauvignon must was extracted with 95 per cent alcohol, and so was a portion of the reconstituted pomace (brought to the original Cabernet Sauvignon volume used) of each blend. Table I shows the color values of the extract pomace and the wine on the basis of optical density per 0.7 gallon of extracted juice. Also shown are the color distribution and the accountable percentage of the color. There is a gradual decline in color, indicating that there is an advantage in blending lesser amounts of Cabernet Sauvignon with larger amounts of the blending material. Except with the 10 and 20 per cent blends the distribution of color between skins and wine is fairly uniform. The accountable color is only about 41 per cent of the total color available at the start of the fermentation.

A second calculation was made of the color balance (Table 2), assuming 90 per cent of the fermented crush as liquid and 10 per cent as solids. This calculation takes into consideration the liquid entrained in the pomace at the time of pressing. Here it is seen that the values for the color of the liquid are reasonably constant. Color distribution is shifted toward the liquid portion. The accountable color values are slightly different for the various blends, but the mean value, as expected, is the same as in table 1.

Several interesting points are evident from these data: 1) The amount of color extracted from the skins is constant and dependent on the amount of skins present; 2) only 41 per cent of the color present at the start of the fermentation was accounted for; and 3) rentention of color in the solids is about equal to that extracted into the liquid.

Wineries in general do remove the entrained liquid from the pomace—usually by a severe pressing. However, there are advantages in pre-fermentation blending in the case of highly pigmented varieties. The color yield of the light press or free run of the ante-fermentation blends will be relatively greater than the color yield of the post-fermentation blend. This is due to the greater entrainment of the liquid in the 100 per cent, undiluted skins and juice at the time of light press. The data shown represent a very light press and show that color yield is increased in the light press by as much as 30 per cent over the post-fermentation blends. The amount of gain, of course, depends on the severity of the light press.

Analysis of the sensory scores of the two blend series (Table 3) shows no significant difference in quality between the ante-fermentation and the post-fermentation blends. Taster x blend interactions are expected, and do exist in both series. The

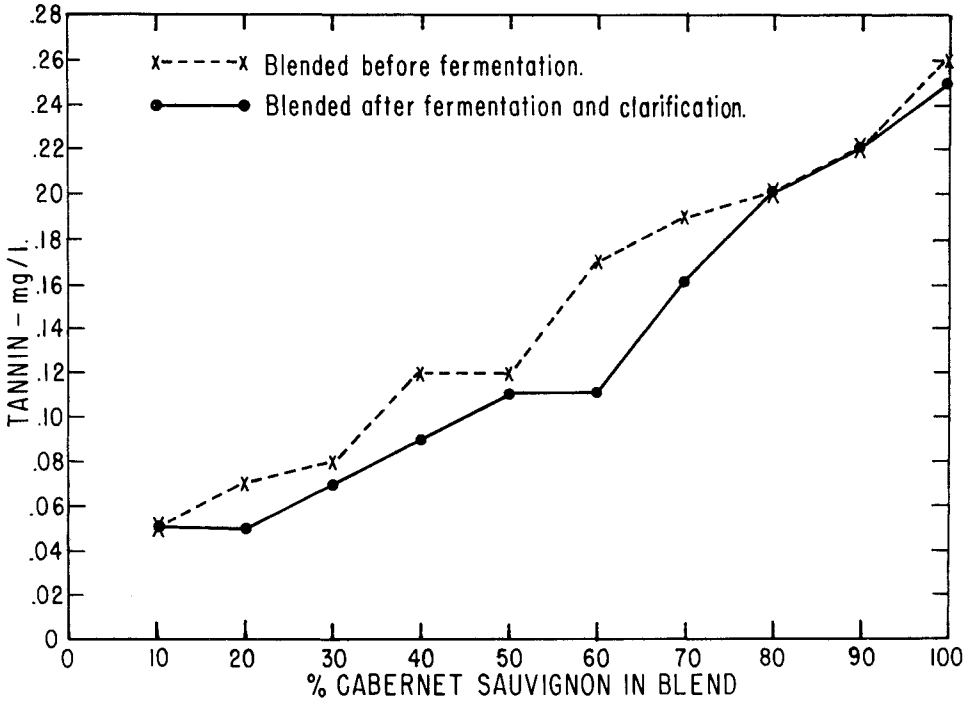

Figure 4. Relationship of the tannin content of the wines made by two blending techniques.

taster x treatment and treatment x blend interactions of the second series are not expected, but can possibly be explained by the fact that the post-fermentation blends were made some four months after completion of fermentation and that storage and clarification procedures varied slightly between the two treatments.

The most significant differences are the blend variances. Since the treatments were insignificant, the pooled blend scores for both treatments were plotted (first series in Figure 5; second in Figure 6). Figures 5 and 6 show a progressive increase in wine quality as the percentage of Cabernet Sauvignon in the blend increases. The quality of the blending wine was better in the first series than the second series, and the slope of the line was not as steep.

There appears to be a maximum-score value at about the 80 per cent blend. This is probably due to the rather high astringency of the 90 and 100 per cent blends. A good linear correlation exists between scores and per cent blends between 10 and 80 per cent in both series.

Figure 6 shows the before and after mean scores of each blend. From this it is seen that the treatment insignificance cannot be attributed to any one or two reversals from a trend.

This does not say that treatment difference could not be shown to exist if more tastings were made or paired or triangle tests were used. However, any differences are indicated to be very small.

CONCLUSIONS

The following conclusions may be drawn:

1) The rate of color extraction (from 2 to 20° Brix change) is relatively independent of extracted color concentration or the amount of pigment material present.

2) The amount of color extracted is de-

TABLE 2

Color-Density Distribution

Between Solids and Liquid of Several Cabernet Sauvignon Blends[a]

Cabernet in blend	Color present[b]			Color distribution between solids and liquid		Accountable color[c] total (%)
	Solids	Liquid	Total	Solid (%)	Liquid (%)	
10	0.80	2.33	3.13	22.5	77.5	23.0
20	2.18	3.17	5.35	40.8	59.2	39.6
30	2.72	2.77	5.49	49.5	50.5	40.5
40	3.31	2.59	5.90	56.1	43.9	43.5
50	3.85	2.91	6.76	57.0	43.0	49.9
60	2.97	2.95	5.92	50.2	49.8	43.6
70	2.71	2.73	5.44	49.8	50.2	40.2
80	3.24	2.89	6.13	52.9	47.1	45.2
90	2.78	2.77	5.55	50.2	49.8	40.9
100	2.50	3.07	5.57	44.8	55.2	41.1
mean value						40.7

[a]On basis of solid and liquid components.

[b]Color based on sum of O.D. at 520 and 420 mμ and adjusted to the basis of O.D. per 0.9 gal. of liquid per gal. of Cabernet must (total solids at time of press estimated at 10% for Cabernet must). Entrained liquid in pressed skins calculated and added to liquid values and subtracted from extracted pressed skin values.

[c]Accountable color is percentage of the total color found when compared on an equivalent basis with the color present in unfermented must (13.57).

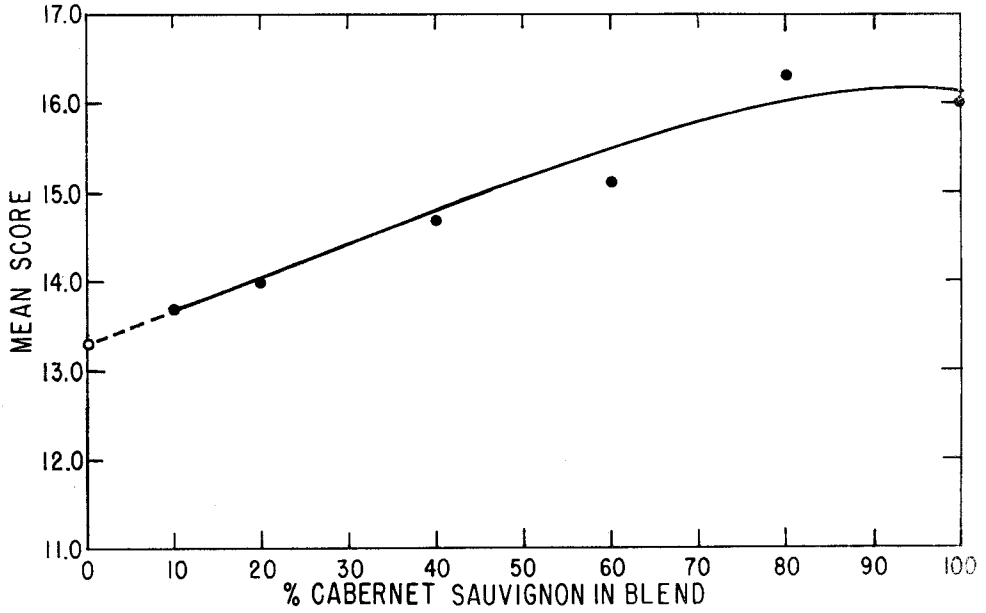

Figure 5. Mean quality scores plotted against percentage blend of Cabernet Sauvignon and Grenache (immediate press).

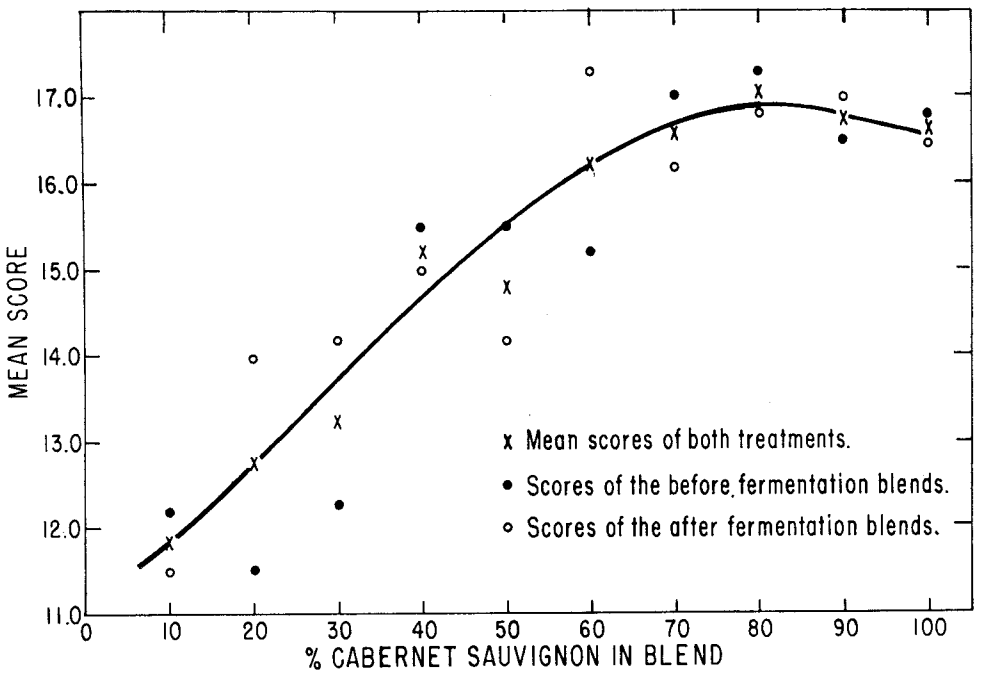

Figure 6. Mean quality scores plotted against percentage blend of Cabernet Sauvignon and miscellaneous white wine.

TABLE 3

Statistical Evaluation of Quality Scores of the Two Cabernet Sauvignon Series of Blends

Source	df	ss	ms
1st blend series			
Total	71	240.87	
Tasters	5	43.12	8.62
Blends	5	67.95	13.59*
Treatments	1	0.01	0.01
Tasters x blends	25	105.30	4.21**
Tasters x treatments	5	0.97	0.18
Blends x treatments	5	3.31	0.66
Error (Residual)	25	20.27	0.81
2nd blend series			
Total	119	671.12	
Tasters	5	29.87	5.97
Blends	9	388.04	43.12**
Treatments	1	2.40	2.40
Tasters x blends	45	130.71	2.90**
Tasters x treatments	5	20.75	4.13**
Blends x treatments	9	51.85	5.76**
Error (Residual)	45	47.50	1.06

* Significant at 5% level.
** Significant at 1% level.

pendent on the amount of pigment material present.

3) The ratio of the distribution of total color between the pigment material and the extracting liquid is independent of the amount of pigment material and the amount of extracting liquid. Approximately a 1:1 ratio existed in all but the lowest blend percentages.

4) Some color yield advantage is gained by ante-fermentation blending with respect to a larger volume of light-press wine obtained as compared to an equal color yield of post-fermentation blends of light-press wine.

5) Approximately 59 per cent of the available color present in the unfermented Cabernet Sauvignon was not present after fermentation, racking, and 4 months of storage.

6) Sensory examination indicated no apparent detectible quality difference between ante-fermentation and post-fermentation blends.

SUMMARY

Investigation of the extraction rate, distribution, and percentage change in pigment amounts from Cabernet Sauvignon grapes during fermentation indicated that extraction rate (from a 2 to 20° Brix change) and distribution of the pigment between the liquid and skins are independent of the amount of extracting liquid and of the amount of pigment material with blends ranging from 20 per cent to 100 per cent Cabernet Sauvignon. Only 41 per cent of the color available at the start of the fermentation was found in the finished wines. No theoretical advantage could be demonstrated by ante-fermentation blending, but some practical considerations indicate that an advantage exists in that, with a larger volume of extracting liquid, a smaller percentage of the extracting liquid is retained on the skins after pressing.

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