

Yield and Quality of Wine Grape Cultivars in Arkansas

R. K. STRIEGLER¹, and J. R. MORRIS²

A survey was conducted to determine the quality and yield of 15 major wine grape cultivars. Six *Vitis vinifera* L., three *Vitis rotundifolia* Michx., and six French-American hybrid cultivars were included in the survey. Fruit maturation was determined by percent soluble solids, TA, and pH measurements. Soluble solids were attained at the expense of acidity and pH. In spite of low soluble solids at acceptable pH levels, pH appeared to be the best parameter by which to monitor maturation and to determine harvest date. Commercially acceptable yields were obtained from all *V. vinifera* and *V. rotundifolia* cultivars.

Little information is available on adaptability and maturation of wine grape cultivars in Arkansas (15). The % soluble solids and grams tartaric acid equivalent/100 mL (TA) have been the parameters most often used to assess grape maturation in the state. Preliminary evaluation of wine grapes in Arkansas have shown low soluble solids (11,13,15,17), low acidity (15,18), and high pH (15,16,18) in fruit at harvest.

Recently, pH has been added as one of the important parameters for monitoring maturation. In wine, pH is important in malolactic fermentation (10), microbial stability (2), taste (2), color stability (9,18,19), stability of soluble grape protein (14), and solubility of potassium bitartrate and calcium tartrate (3,4). Amerine and Ough (1) indicate that wines with a pH above 3.6 may have stability problems. Also, adjustments in pH are more difficult to make than adjustments in % soluble solids and acidity.

This study was initiated to evaluate fruit maturity parameters and to determine maturation rates of some of the major wine grape cultivars grown in Arkansas. Yield was also determined because of its influence on quality and cultivar selection (20).

Materials and Methods

Fifteen cultivars from three species of grapes were monitored during 1979 and 1980. The *V. vinifera* L. cultivars tested were Cabernet Sauvignon (red), Petite Sirah (red), Pinot noir (red), Gewurztraminer (white), White Riesling (white), and Chardonnay (white). The French-American hybrid cultivars tested were Villard noir (red), de Chaunac (red), Baco noir (red), Villard blanc (white), Aurore (white), and Seyval (white). The *V. rotundifolia* Michx. cultivars were Noble (red), Carlos (white), and Magnolia (white). The *V. vinifera* and French-American hybrid cultivars were evaluated in commercial vineyards at Altus, Arkansas, and the *V. rotundifolia* cultivars were evaluated in a commercial vineyard at Forrest City, Arkansas.

The 1979 season was cool and wet, but the 1980 season was hot and dry. Generally, the combined effects of drought and high temperatures in 1980 produced the most unfavorable climatic conditions for viticulture in Arkansas since 1936 (J. R. Morris, unpublished data).

Two replications of each cultivar consisted of three mature, uniformly growing, healthy vines, separated by appropriate guard vines. All data were subjected to analysis of variance and F-tests. Quality data were analyzed as a factorial, and only the interactions of cultivar x sampling date are presented. LSD was used to separate means.

Fruit quality determinations: After veraison, fruit samples were collected at an early, mid, and late stage of maturity. Each sample consisted of at least 200 randomly selected berries from each replication which were sealed in polyethylene bags, stored on ice, and transported to the University of Arkansas Food Science Laboratory at Fayetteville where they were immediately frozen for later analyses.

At the time of analysis, thawed samples were blended for 30 seconds in a laboratory blender and then placed in a 250 mL beaker which was covered with a watch glass. The samples were then heated for one hour at 85°C in a water bath, allowed to cool, and squeezed through two layers of cheesecloth. The resulting juice was centrifuged for 10 minutes at 2100 g.

Percent soluble solids was determined using a Bausch and Lomb Abbe refractometer. A 5 mL aliquot of juice was diluted to 125 mL with deionized H₂O and then titrated to pH 8.4 with 0.1 N NaOH to determine acidity. Acidity is expressed as g tartaric acid equivalent per 100 mL. The pH was determined using a Corning (Model 130) pH meter.

Yield determination: Following the late fruit sampling, the vines were harvested and individual vine yields recorded. Pruning weight for each vine was obtained in January each year.

Results and Discussion

In 1979, the highest yielding red cultivars were Noble, Petite Sirah, and Cabernet Sauvignon. Among the white cultivars Magnolia, Carlos, and Villard blanc produced the highest yields (Table 1). The Pinot noir, Noble, and Petite Sirah were the highest yielding red cultivars in 1980. The white cultivars having the highest yields were Carlos and

¹Graduate Assistant and ²Professor, Department of Food Science, University of Arkansas, Fayetteville, AR 72701

Published with the approval of the Director of the Arkansas Agricultural Experiment Station

Magnolia. Apparently, the Villard blanc was the lowest yielding cultivar in 1980 because it was overcropped in 1979. However, all *V. vinifera* and *V. rotundifolia* cultivars had commercially acceptable yields (above 9 t/ha) during the two years of the study. Probably, many of these cultivars were allowed to overproduce during this study. Further study is needed to determine the reason for the observed variability in yield.

Table 1. Yield and pruning weights of wine grapes in 1979 and 1980.

Cultivar	1979		1980	
	Yield (t/ha)	Pruning weight (kg/vine)	Yield (t/ha)	Pruning weight (kg/vine)
Red				
Cabernet Sauvignon	17.9	1.9	15.2	2.2
Petite Sirah	18.4	2.4	20.4	1.2
Pinot Noir	14.5	2.6	28.3	1.8
Villard Noir	12.2	— ²	8.4	0.5
DeChaunac	13.9	1.3	10.9	1.5
Baco Noir	10.6	0.9	9.2	1.3
Noble	21.2	3.4	21.5	4.4
White				
Gewürztraminer	13.2	1.4	11.8	1.4
White Riesling	9.6	1.2	14.6	1.0
Chardonnay	11.4	1.3	18.0	1.4
Villard Blanc	20.2	—	9.3	—
Aurore	9.0	—	13.6	—
Seyval	12.9	—	10.9	0.4
Carlos	22.4	2.6	28.8	4.5
Magnolia	23.7	2.4	25.7	2.5
LSD @ 5%	5.0	1.0	5.1	0.4

² Data not available.

Although the pruning weight data are incomplete, an examination of the information available shows that Noble had the highest pruning weights both seasons (Table 1). Also, the other two *V. rotundifolia* cultivars, Carlos and Magnolia, had consistently high pruning weights. Cultivars of this species produced very high yields which may be related to their general vine size, since fruiting potential in properly managed vines usually increases as vine size increases.

Examination of the interaction of cultivar X sampling date showed that the rate of increase in percent soluble solids of all the red cultivars was fairly constant in both 1979 and 1980 (Table 2). However, by the final sampling the Noble cultivar had developed only 16.8% and 14.1% soluble solids for 1979 and 1980, respectively. There were significant interactions for cultivar X sampling date for acidity and pH in 1979 (Table 2). The Baco noir cultivar showed little or no reduction in acidity between the second and third sampling date.

In addition, the pH of Pinot noir, de Chaunac, and Baco noir did not increase as much as did the pH of the other red cultivars between the second and third sampling dates. In 1980, all quality measurements on the red cultivars changed as expected as sampling date progressed.

The percent soluble solids increased for the white cultivars in 1979. However, during the stress year of 1980, White Riesling, Carlos, and Magnolia did not show the expected increase in % soluble solids (Table 3). It is possible that the 14.6 t/ha, 28.8 t/ha, and 25.7 t/ha, respectively, were excessive loads for these cultivars under the hot, dry conditions of 1980.

In 1979, Chardonnay, Villard blanc, and Carlos did not show the expected drop in acidity until the final sample date (Table 3).

That year, Chardonnay, Seyval, and Carlos did not increase significantly in pH until the final sampling date (Table 3). The pH of the other white cultivars increased with each consecutive sampling date. In 1980, the acidity of Chardonnay and Magnolia did not decrease as much as that of the other cultivars between the second and third sampling dates (Table 3). The White Riesling, Carlos, and Magnolia were the best of the white cultivars in maintaining a low pH during 1980. Both *V. rotundifolia* cultivars had extremely low pH levels at all sampling dates in this hot, dry season. An extremely high pH and low acidity occurred with Gewurztraminer in both the 1979 and 1980 seasons. Carter *et al.* (8) have shown that white grape samples blended in a Waring blender were 0.2 to 0.3 higher in pH than samples prepared by grinding in a "Squeeze" strainer, pressing in a laboratory press, or pressing in a potato ricer. The use of a nonblending method for sample preparation of the white cultivars would have given more representative pH values. However, these adjusted pH values still would have been excessive by the final harvest on Gewurztraminer in the more normal year of 1979 and for Gewurztraminer, White Riesling, Chardonnay, and Villard blanc cultivars in the excessively hot year of 1980.

Table 2. Effects of cultivar and sampling date on raw product quality of red wine grapes in 1979 and 1980.

Cultivar and sampling date	1979			1980			
	Soluble solids (%)	TA (%)	pH	Soluble solids (%)	TA (%)	pH	
1979	1980						
Cabernet Sauvignon							
8/8	8/11	14.6	1.21	3.20	17.0	0.78	3.49
8/22	8/20	16.7	0.91	3.43	18.0	0.72	3.56
9/4	9/3	18.5	0.65	3.58	20.5	0.61	3.67
Petite Sirah							
8/8	8/11	14.5	1.22	3.29	15.0	1.00	3.51
8/15	8/20	16.4	1.05	3.40	17.2	0.82	3.70
8/22	8/27	17.3	0.88	3.52	19.3	0.79	3.75
Pinot Noir							
8/1	8/1	12.9	1.54	3.30	15.4	0.95	3.70
8/8	8/8	16.1	1.10	3.53	18.6	0.73	4.02
8/15	8/15	17.2	0.99	3.61	19.5	0.62	4.06
Villard Noir							
8/15	7/30	16.4	1.24	3.05	10.9	1.48	3.38
8/22	8/6	17.8	1.02	3.19	12.7	1.22	3.55
8/29	8/11	18.8	0.82	3.53	14.0	1.05	3.63
DeChaunac							
7/25	7/23	15.7	1.25	3.05	12.6	1.08	3.11
8/1	7/30	17.2	1.00	3.20	15.4	0.96	3.24
8/8	8/6	17.4	0.88	3.29	17.2	0.80	3.36
Baco Noir							
7/21	7/23	15.9	1.87	3.11	17.4	1.44	3.29
8/1	7/30	18.8	1.29	3.35	20.0	1.25	3.43
8/8	8/7	19.4	1.27	3.41	23.7	0.94	3.63
Noble							
9/4	9/8	12.6	0.87	3.21	12.3	1.36	2.97
9/18	9/21	14.0	0.73	3.29	13.8	1.00	3.12
10/1	10/2	16.8	0.65	3.46	14.1	0.94	3.20
LSD@5%		NS	0.14	0.05	NS	NS	NS

Conclusions

Yields were extremely high on many of the cultivars evaluated. With some cultivars, overcropping could probably be contributed to a low percent soluble solids. With the three *V. rotundifolia* cultivars, the genetic potential and the characteristic of the fruit to form an abscission layer and drop from the vine at maturity would prevent the formation of high levels of soluble solids. The hot, dry year of 1980 was extremely damaging to the pH and acidity levels of most of the *V. vinifera* cultivars. The *V. rotundifolia* cultivars were the most tolerant of the high temperatures of 1980 in terms of maintaining low pH and high acidity levels.

Consistent differences in ripening were observed among the cultivars and further investigation is needed to determine the causes of these variations and to evaluate their influences on wine quality. Soluble solids were attained at the expenses of acidity and pH, with the exceptions of the low soluble solid *V. rotundifolia* cultivars. It is important that Arkansas wineries closely monitor the fruit pH level and use this parameter as a major factor in determining optimum harvest time. The use of pH as the primary criterion in selecting harvest date has been previously advocated by LaRosa (12). The yields obtained from these cultivars were considered to be commercially acceptable, in most cases, and overcropping was thought to contribute to the production of low soluble solids with some of the *V. vinifera* and French hybrid cultivars. The effects of various levels of yields on quality of these cultivars need further investigation.

Table 3. Effects of cultivar and sampling date on raw product quality of white wine grapes in 1979 and 1980.

Cultivar and sampling date	1979			1980		
	Soluble solids (%)	TA (%)	pH	Soluble solids (%)	TA (%)	pH
1979 1980						
Gewurztraminer						
8/1 7/23	14.8	0.94	3.35	13.0	1.08	3.50
8/8 8/1	18.1	0.70	3.56	15.1	0.73	3.74
8/15 8/11	20.4	0.53	3.74	18.4	0.56	3.98
White Riesling						
8/1 8/1	14.1	1.37	3.10	11.2	1.20	3.20
8/8 8/11	16.7	1.07	3.27	14.0	0.86	3.37
8/15 8/27	17.4	0.81	3.36	14.9	0.75	3.41
Chardonnay						
8/1 7/23	14.6	1.12	3.37	12.2	1.63	3.25
8/6 8/6	16.7	0.91	3.50	7.7	0.83	3.66
8/15 8/19	19.0	0.78	3.69	21.8	0.66	3.86
Villard Blanc						
8/22 8/14	14.7	0.93	3.47	18.5	0.79	3.69
8/29 8/20	16.9	0.86	3.59	20.4	0.73	3.79
9/4 8/27	20.8	0.60	3.66	23.4	0.63	3.93
Aurore						
7/25 7/16	13.1	1.57	3.09	10.8	1.98	3.06
8/1 7/23	15.1	1.12	3.31	14.2	1.22	3.24
8/8 7/30	17.8	0.92	3.47	16.5	0.98	3.48
Seyval						
7/25 7/23	14.9	1.44	3.11	15.1	1.31	3.17
8/8 7/30	16.0	1.29	3.17	18.2	1.08	3.34
8/15 8/6	20.4	0.87	3.46	19.9	0.88	3.50
Carlos						
9/4 9/8	12.8	0.96	3.18	13.3	1.36	3.02
9/18 9/21	14.0	0.99	3.20	15.1	1.22	3.01
0/1 10/2	15.8	0.80	3.34	14.8	1.14	3.07
Magnolia						
9/4 9/9	10.2	1.19	2.93	12.8	1.33	2.91
9/18 9/21	11.9	0.91	3.06	13.3	1.31	3.00
10/1 10/2	15.1	0.74	3.20	13.3	1.09	3.08
LSD @ 5%	NS	0.14	0.06	1.4	0.18	4.00

Literature Cited

1. Amerine, M. A., and C. S. Ough. Wine and Must Analysis. John Wiley and Sons. New York (1974).
2. Amerine, M. A., H. W. Berg, R. E. Kunkee, C. S. Ough, V. L. Singleton, and A. D. Webb. The Technology of Wine Making. AVI Publishing Co. Westport, CT (1980).
3. Berg, H. W., and R. M. Keefer. Analytical determination of tartrate stability in wine. I. Potassium bitartrate. Am. J. Enol. Vitic. 9:180-93 (1958).
4. Berg, H. W., and R. M. Keefer. Analytical determination of tartrate stability in wine. II. Calcium tartrate. Am. J. Enol. Vitic. 10:105-9 (1959).
5. Boulton, R. The general relationship between potassium, sodium, and pH in grape juices and wines. Am. J. Enol. Vitic. 31:182-6 (1980).
6. Boulton, R. A hypothesis for the presence, activity, and role of potassium/hydrogen adenosine triphosphatases in grapevines. Am. J. Enol. Vitic. 31:283-7 (1980).
7. Boulton, R. The relationship between total acidity, titratable acidity, and pH in grape tissue. Vitis. 19:113-20 (1980).
8. Carter, G. H., C. W. Nagel, and W. J. Clore. Grape sample preparation methods representative of must and wine analysis. Am. J. Enol. Vitic. 23:10-13 (1972).

9. Jurd, L. Anthocyanins and related compounds. I. Structural transformation of flavylum salts in acidic solutions. *J. Org. Chem.* 28:987-91 (1963).
10. Kunkee, R. E. Malo-lactic fermentation and winemaking. *In: Chemistry of Winemaking*, A. D. Webb (Ed.), Am. Chem. Soc. (1974).
11. Lanier, M. R., and J. R. Morris. Evaluation of density separation for defining fruit maturities and maturation rates of once-over harvested muscadine grapes. *J. Am. Soc. Hort. Sci.* 104:24952 (1979).
12. La Rosa, W. V. Maturity of grapes as related to pH at harvest. *Am. J. Enol. Vitic.* 6:42-4 (1955).
13. Moore, J. N. Performance of muscadine grape varieties in Arkansas. *Ark. Agric. Stn. Rep. Ser.* 200 (1972).
14. Moretti, R. H., and H. W. Berg. Variability among wines to protein clouding. *Am. J. Enol. Vitic.* 16:69-78 (1965).
15. Morris, J. R., C. A. Sims, J. E. Bourque, and J. L. Oaks. Influence of training system, pruning severity, and spur length on yield and quality of six French-American hybrid grape cultivars. *Am. J. Enol. Vitic.* 35:23-7 (1984).
16. Radvanyi, J., Jr., B. J. Stojanovic, W. J. Drapala, J. P. Overcash, and C. P. Hegwood, Jr. Composition and quality of juices and wines of eight *Vitis rotundifolia* Michx. cultivars. *Am. J. Enol. Vitic.* 31:316-22 (1980).
17. Reynolds, H., and J. E. Vaile. Chemical composition of Arkansas-grown grapes. *Ark. Agric. Exp. Stn. Bull.* 420 (1942).
18. Timberlake, D. F., and B. Bridle. Flavylum salts, anthocyanidins, and anthocyanins. I. Structural transformations in acid solutions. *J. Sci. Food Agric.* 18:473-8 (1967).
19. Van Buren, J. P., G. Hrazdina, and W. B. Robinson. Color of anthocyanin solutions expressed in lightness and chromaticity terms. Effect of pH and type of anthocyanin. *J. Food Sci.* 39:325-8 (1974).
20. Winkler, A. J., J. A. Cook, W. M. Kliewer, and L. A. Lider. *General Viticulture*. University of California Press, Berkeley. (1974).