Literature Cited

1. Berkson, G. 1955. "Maximum likelihood and minimum Chi square estimates of the logistic function." J. Amer. Stat. Assoc. 70:130-61.
2. Bewey, Ronald and Trevor Young. 1987. "Applying Theil's multinomial extension of the linear logit model to meat expenditure data." Amer. J. Agr. Econ. 69:151-157.
3. Debertin, David L., et al. 1980. "Estimating linear probability functions: A comparison of approaches." S. J. Agr. Econ. 12:65-69.
4. Degner, Robert, et al. 1980. "Fresh market potential for muscadine grapes." The Florida Agri. Mkt. Res. Ctr. University of Florida.
5. Florida Department of Agricultural and Consumer Services. 1988. "Commercial production, processing and marketing of muscadine fruit juice and deseeded canned fruit." Tallahassee, Florida.
6. Francois, Coral F. and Jerry Law. 1972. "Marketing guidelines for Louisiana vegetable producers." Dept. Agr. Econ., Louisiana State University, DAE, Report No. 443.
7. Free, W. J. 1979. "The small farmers' marketing needs in the south." Proc. Mkt. Alt. for Small Farmers—Fruits and vegetables. Tennessee Valley Authority.
8. Halbrooks, M. C. 1986. "Viticulture in Florida: The next five years." Proc. Fl. St. Hort. Soc. 99:189-192.
9. Helms, Ted. 1986. "Marketing grapes." Proc. Vit. Sc. Symp., Florida A&M University.
10. Intrilligator, Michael D. 1978. Econometric models, techniques & applications. Prentice Hall, Inc.
11. Kmenta, Jan. 1986. Elements of econometrics. 2nd Ed., MacMillan Publishing.
12. Law, Jerry M. and John Ellerman. 1983. "Market alternatives for Louisiana vegetable growers." Dept. Agr. Econ., Louisiana State University, DAE, Report No. 621.
13. McFadden, Daniel. 1974. "Conditional logit analysis of qualitative choice behavior." Frontiers in Econometrics, Ed. Paul Zarembka. Academic Press.
14. Montgomery, Douglas and Elizabeth Peck. 1982. Introduction linear regression analysis. John Wiley.
15. Pindyck, Roberts and Daniel L. Rubinfeld. 1981. Econometric models & economic forecasts. 2nd Ed., McGraw Hill.
16. Sanathanan, Lilitha. 1974. "Some properties of the logistic model for dichotomous response." J. Amer. Stat. Assoc. 69:744-749.
17. Savoy, Clifton, F. 1981. "Muscadine marketing considerations." Proc. Vit. Sc. Symp., Florida A&M University.
18. Smith, Brian. 1989. "Production and marketing of muscadine grapes by hobby farmers and small-scale grape growers in north Florida." Unpublished masters thesis, Div. Agr. Sc., Florida A&M University.

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EVALUATION OF WINE POTENTIAL FROM BREEDING LINES AND CULTIVARS IN FLORIDA

CHARLES A. SIMS
University of Florida, IFAS
Food Science and Human Nutrition Department
Gainesville, FL 32611

JOHN MORTENSEN
University of Florida, IFAS
Central Florida Research and Education Center
Leesburg, FL 32748

Abstract. **The raw fruit and wine quality of promising grape breeding lines and cultivars in Florida were evaluated. The breeding lines CB 9-23 and AD 1-115 had the best color and wine sensory scores of the red bunch (*Euvitis* hybrids) grapes evaluated. Noble had the best color and sensory scores of the red muscadine (*Vitis rotundifolia*) grapes evaluated, although the breeding lines CA 4-46 and NC 15-17 also had good color and sensory scores. The breeding line E 18-63 seems to be the most promising of the white bunch grape breeding lines, but Blanc du Bois and Suwannee had much higher sensory scores. The white muscadine breeding lines AD 3-42 and CA 9-50 seem to offer as much wine potential as several currently used white muscadine cultivars.**

There are currently several commercially acceptable grape cultivars for wine production in Florida, but new and improved cultivars are still needed to improve the competitiveness and product mix of Florida wines (3, 5, 7). For instance, very few red bunch grape (non-muscadine) wines have ever been produced in Florida due to a lack of suitable cultivars (5). Most red bunch grapes (*Euvitis* hybrids) and muscadine grapes (*Vitis rotundifolia*) in Florida have relatively poor color and color stability (3, 5), and as a consequence, cultivars with improved color are needed. In addition, white bunch grape cultivars that produce unique and commercially acceptable wines are also needed to compliment the current white bunch grapes. A very active breeding program at the University of Florida has released several new grape cultivars over the years (6, 8), and many of these are for, or could be for, wine production.

A wine evaluation process is necessary because it is usually very difficult or impossible to predict the wine quality of a cultivar without actually producing wine, storing it and evaluating it (3). The soluble solids, pH, acidity and flavor of the grapes are usually only rough indices of the potential wine quality. One of the functions of the grape processing and enology program at the University of Florida is the evaluation of cultivars and breeding lines for wine production in Florida. This report will summarize the results of this cultivar evaluation in 1986.

Materials and Methods

All grapes were obtained from the University of Florida's Central Florida Research and Education Center at Leesburg and usually crushed the same day of harvest. The breeding lines and cultivars evaluated are shown in Table 1. Wines were produced using standardized wine making procedures described below.

White wines. White bunch and muscadine grapes were crushed, treated with 50 ppm sulfite and pressed in a basket press. The resulting juice was analyzed for soluble solids (using a refractometer), pH and acidity (titration) and allowed to settle overnight at 2°C. The juice was then adjusted to 21% soluble solids using sucrose to provide sufficient ethanol in the wine. The juice was then innoculated with Pasteur Champagne yeast and allowed to ferment to dryness (less than 0.5% reducing sugar) at 13°C in glass carboys. The wine was racked several times, cold stabilized by placing at 2°C for 7-10 days and then filtered through

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Table 1. Raw fruit quality of grapes, 1986 harvest.

Breeding Line or Cultivar	Soluble Solids (%)	Titratable Acidity (%)	pH
Red Bunch Grapes			
CB 9-23	18.2	1.10	3.35
Meridan 4-19A	18.9	1.16	3.44
CD 12-25	16.3	1.10	3.33
AD 1-115	16.6	1.03	3.44
H 17-22	17.6	0.86	3.39
Black Spanish	18.4	1.36	3.33
Red Muscadine Grapes			
CA 4-46	14.8	0.72	3.36
Noble	16.0	0.38	3.55
CA 6-35	14.5	0.68	3.29
Alachua	16.2	0.65	3.48
NC 15-17	14.0	0.75	3.34
White Bunch Grapes			
F 12-8	19.3	1.05	3.49
E 18-63	16.4	0.75	3.58
L 9-10	16.2	0.92	3.31
NC 29-7	16.8	0.74	3.48
BD 7-16	17.4	0.92	3.35
Blanc du Bois	16.9	1.05	3.56
Stover	16.1	0.78	3.16
Lake Emerald	17.5	1.16	3.58
Suwannee	14.8	1.08	3.38
White Muscadine Grapes			
CA 9-50	14.6	0.53	3.32
GA 23-45	14.0	0.61	3.39
AD 3-42	13.4	0.62	3.34
Doreen	13.8	0.62	3.35
Dixie	15.3	0.48	3.64

medium grade cellulose pads to clarify the wine. The wine was then bottled, corked and allowed to age for 8-10 months prior to analysis.

All routine wine analyses were conducted, but only the color and overall sensory scores are presented due to the importance of these parameters. The wines were analyzed initially and after one year of storage at 13°C. Color was measured by detemining the absorbance (abs.) at 420 nm with a spectrophotometer. The wines were submitted to a semi-trained sensory panel consisting of 10-15 members. The wines were rated on a 9-point Hedonic scale, with 9 = excellent, 5 = acceptable, and 1 = very poor.

Red wines. Red bunch and muscadine grapes were crushed, treated with 50 mg/L sulfite and analyzed for soluble solids, pH and acidity. The crushed grapes were innoculated with Montrachet yeast and allowed to ferment "on the skins" for 64-72 hr at 18°C. The grapes were stirred twice daily to insure good exposure of the skins to the fermenting juice. The grapes were then pressed, adjusted to 21% soluble solids (based on the original soluble solids) and allowed to ferment to dryness at 13°C in glass carboys. The remaining steps were indentical to those for the white wines, except the wines were analyzed initially and after 1 and 2 years of storage at 13°C. The analysis of the red wines was identical to that for the white wines, except the color was measured by determining the absorbance at 520 nm.

Results and Discussion

Red bunch grapes (Euvitis hybrids). The soluble solids of the red bunch grapes ranged from 16-19% (Table 1), which would be considered low compared to some grape growing areas (1). However, the addition of sugar to grape juice to adjust the soluble solids to 20-22% is legal in the eastern United States, and is usually necessary to insure adequate levels of ethanol for a stable wine. The titratable acidity ranged from 0.86-1.4%, which would generally be considered high for wines (1). These high acid levels could lead to harsh, acidic or unbalanced wines. There are ways to reduce the acidity in wines, but these methods may not be desirable in these wines since they also tend to increase pH (1). The pH levels of these grapes are about optimum for red wines, but increases in pH above 3.5 may be undesirable for wine production (1). Although the soluble solids will increase and the acidity will usually decrease with further ripening, the possibilities of a high pH limits the maximum soluble solids accumulation since the pH usually increases with further ripening (1, 4). Thus, if these grapes are harvested at an optimum pH, which is the most difficult parameter to adjust, wine-makers often must deal with low soluble solids and high acidity.

The wine analysis indicated that there was a good deal of variation in wine color among the breeding lines and cultivars. The breeding line CB 9-23 had very good color as indicated by the high abs. at 520 nm (Fig. 1) and high sensory color ratings (data not shown). Although the color intensity decreased after 1 and 2 years of storage, this wine still had much better color than the other red bunch grape wines. The breeding lines AD 1-115, Black Spanish and Meridian 4-19A all had fair to good color, but CD 12-25 and H 17-22 produced wines with poor color. The color of red wines is determined to a large extent by the type and quantity of anthocyanins in the wine (1, 2), and to a lesser extent, numerous other factors such as pH (9). Although the anthocyanin composition of these breeding lines are currently unknown, it is very likely that there are substantial variations in anthocyanin composition among these breeding lines since there is such a variation in color.

The overall sensory scores correlated fairly well with the color (Fig. 2). The breeding line CB 9-23, which had the best color, also had the best overall sensory score after 1 and 2 years of aging. This breeding line had very little or no "labrusca" character and produced a full-bodied, highly acceptable red table wine. Black Spanish, AD 1-115 and Meridian 4-19A were all rated acceptable (score of 5) or above after 2 years of aging and may offer some poten-

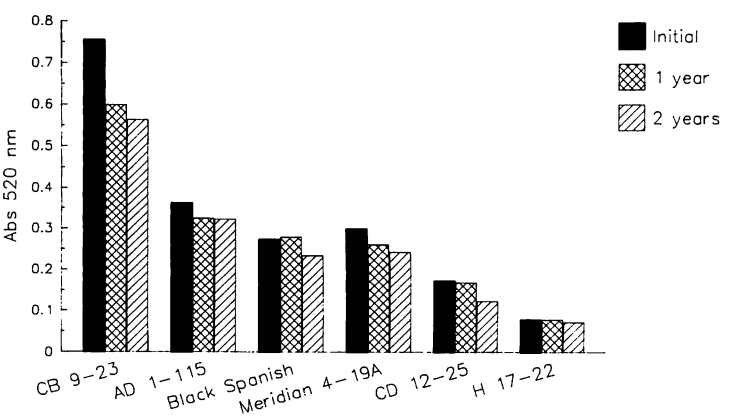

Fig. 1. Color (abs. 520 nm) of red bunch grape wines initially and after 1 and 2 years of storage. A higher value indicates a darker red and more desirable color.

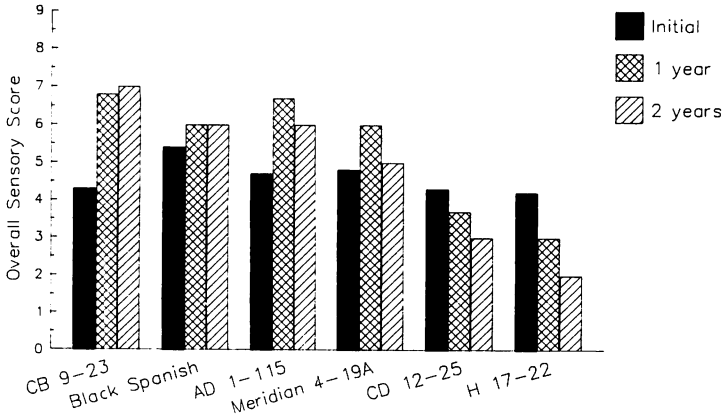

Fig. 2. Overall sensory scores of red bunch grape wines initially and after 1 and 2 years of storage. A 9 = excellent, a 5 = acceptable and a 1 = very poor.

tial as red wine grapes. The sensory scores of these wines increased after 1 year, illustrating the beneficial effects of aging of red wines. The breeding lines CD 12-25 and H 17-22 produced wines with unacceptable sensory ratings.

Red muscadine grapes (Vitis rotundifolia). The red muscadine grapes had lower soluble solids (14-16%) and acidity levels (0.38-0.75%) than the red bunch grapes as a whole (Table 1), which are common characteristics of muscadines in general. The acidity levels of the muscadines, with the exception of Noble, are in an ideal range for wines, and the soluble solids can be adjusted as mentioned previously. The pH values were all in an acceptable range with the exception of Noble, which had a rather high pH (above 3.5) this year. This is ironic, because Noble produced the best wine of all the breeding lines, yet does not have the "ideal" pH.

The standard red muscadine cultivar for wine, Noble, had better color than any of the breeding lines both initially and after storage (Fig. 3). However, the breeding lines CA 4-46 and NC 15-17 also produced wines with good color initially, although the color did deteriorate during storage. The cultivar Alachua and the breeding lines CA 6-35 had very poor color and color stability. As with the red bunch grapes, there is undoubtedly variation in the anthocyanin composition among the red muscadines that could lead to these color differences. Noble is known to contain rather high levels of the more stable diglucoside

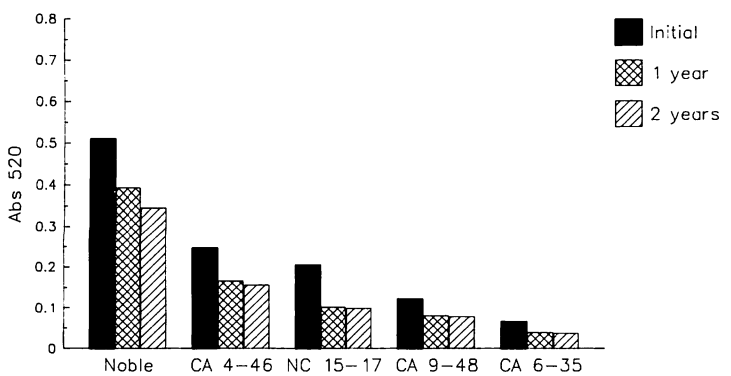

Fig. 3. Color (abs. 520 nm) of red muscadine wines initially and after 1 and 2 years of storage. A higher value indicates a darker red and more desirable color.

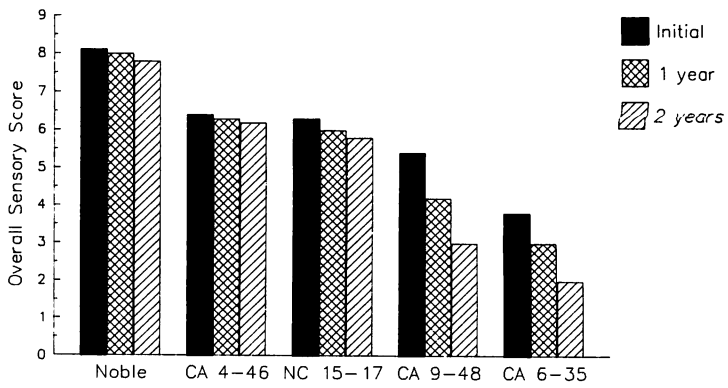

Fig. 4. Overall sensory scores of red muscadine wines initially and 1 after and 2 years of storage. A 9 = excellent, a 5 = acceptable and a 1 = very poor.

anthocyanins (2). In addition, Noble grapes are small for muscadines, and thus there is a lot of skin area (and hence anthocyanins) per berry.

Noble also had the highest sensory scores of all the red muscadines, but CA 4-46 and NC 15-17 also had highly acceptable scores (Fig. 4). Although Noble seems to be the best red muscadine wine grape of the muscadines we have tested, CA 4-46 and NC 15-17 may also offer good potential as wine grapes. All three of these wines had the nice "fruity" muscadine character associated with these grapes. Alachua and the breeding line CA 6-35 had poor sensory scores in addition to poor color.

White bunch grapes (Euvitis hybrids). The soluble solids of the white bunch grapes ranged from 14.8-19.3% and the acidity from 0.74-1.16% (Table 1), which are similar to those of the red bunch grapes. The pH of several of these grapes was higher than recommended for white wines (greater than 3.4). Thus, the pH values limit the accumulation of soluble solids and reductions in acidity through increased ripening, just as with the red bunch grapes. However, some of these grapes with high pH still produce acceptable to good wines (Fig. 6).

Suwannee was lighter in color and less brown (lower abs. 420 nm) than the other white bunch grapes. However, Stover, E 18-63, L 9-10 and Blanc du Bois all had good color (light with limited browning). The breeding lines BD 7-16 and especially NC 29-7, Lake Emerald and F 12-8 all

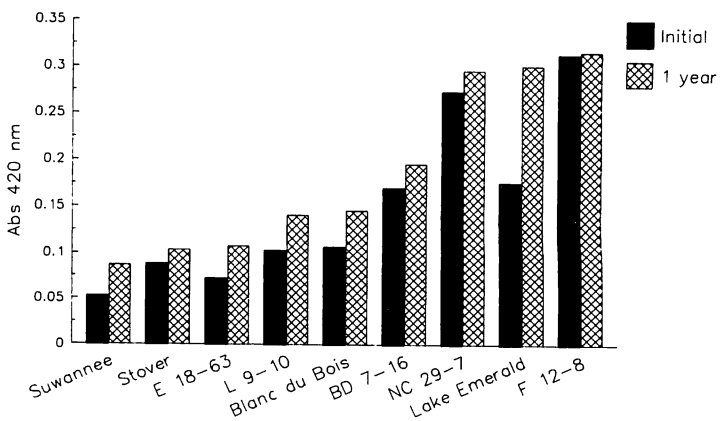

Fig. 5. Color (abs. 420 nm) of white bunch grape wines initially and after 1 year of storage. A higher value indicates a darker yellow or brown and a more undesirable color.

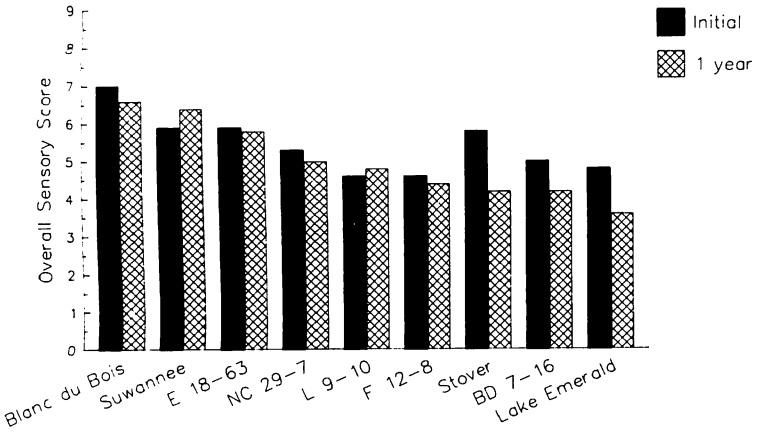

Fig. 6. Overall sensory scores of white bunch grape wines initially and after 1 year of storage. A 9 = excellent, a 5 = acceptable and a 1 = very poor.

browned extensively as indicated by the high abs. at 420 nm. This browning problem could limit the use of these grapes for white wine production.

Blanc du Bois and Suwannee had better sensory scores than any of the other white bunch grapes initially and after 1 year (Fig. 6). Although Blanc du Bois was rated considerably higher than Suwannee initially, they had similar scores after 1 year of storage. Both of these cultivars produced highly acceptable wines with unique character, and are being used extensively by wineries in Florida. The breeding lines E 18-63 and NC 29-7 also had acceptable ratings, but had no outstanding sensory characteristics. The breeding line E 18-63 has just recently been eliminated as a potential grape for Florida due to suseptibility to Pierce's disease, but the breeding line NC 29-7 merits further investigation. The other white bunch grapes produced wines that were rated less than acceptable. The cultivar Stover, which is currently used as a wine grape in Florida, had a good rating initially, but not after 1 year. In other studies we have conducted and in other years, Stover generally produces an acceptable wine (data not shown).

White muscadine grapes (Vitis rotundifolia). The white muscadine grapes had rather low soluble solids (13-15%) and titratable acidity (0.48-0.62%), which is similar to the red muscadine grapes (Table 1). The soluble solids:acidity ratio (sugar:acid balance) of all these white muscadines was acceptable (22-28) with the exception of Dixie. Dixie had

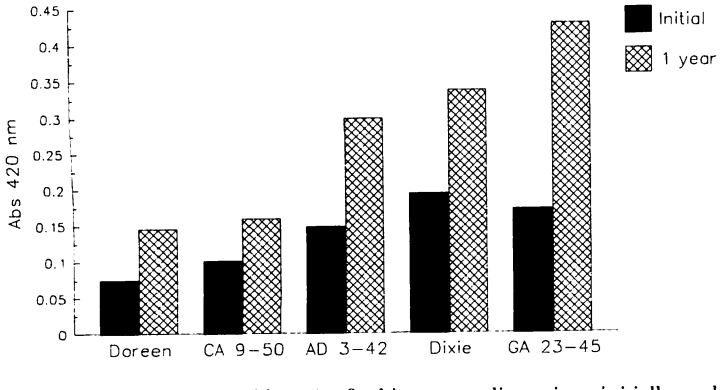

Fig. 7. Color (abs. 420 nm) of white muscadine wines initially and after 1 year of storage. A higher value indicates a darker yellow or brown and a more undesirable color.

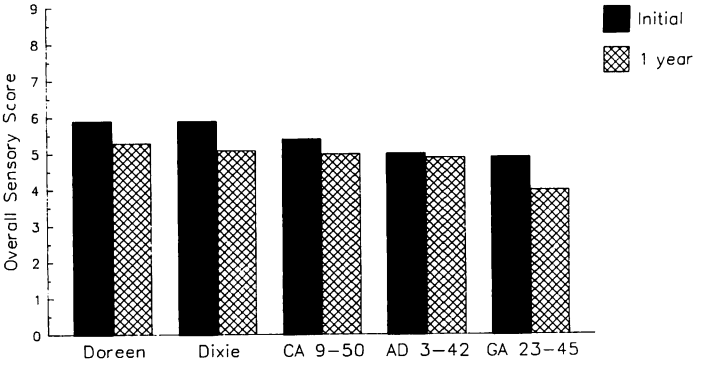

Fig. 8. Overall sensory scores of white muscadine wines initially and after 1 year of storage. A 9 = excellent, a 5 = acceptable and a 1 = very poor.

a rather high soluble solids:acid ratio of 32. The soluble solids:acidity ratio is very important in the quality of grape juice, with a soluble solids:acidity ratio of 22-28 being the most acceptable in general. The pH values of the white muscadines were all within an acceptable range for wine with the exception of Dixie.

Wines from AD 3-42, Dixie and especially GA 23-45 tended to be rather dark (yellow to brown) initially and browned extensively after 1 year of storage (Fig. 7). However, Doreen and CA 9-50 had relatively stable wine color. This browning problem is severe in some of the white muscadines and could limit their use as wine grapes. There was very little difference in overall sensory scores between the breeding lines tested, but GA 23-45 had a slightly lower sensory rating than the others after 1 year due to the harshness of this wine (Fig. 8). All of the white muscadine wines had the very fruity muscadine character, with only minor sensory differences between the cultivars and breeding lines.

Conclusions

CB 9-23 showed the most potential as a red bunch grape, with Black Spanish, AD 1-115 and Meridian 4-19A having lesser potential. Noble was the best of the red muscadines evaluated, but CA 4-46 and NC 15-17 also produced good red muscadine wines. Blanc du Bois and Suwannee were the best of the bunch grapes evaluated, but Stover and L 9-10 also have some promise as wine grapes. Several white muscadine grapes made acceptable, but similar, wines.

Literature Cited

1. Amerine, M. A., H. W. Berg, R. E. Kunkee, C. S. Ough, V. L. Singleton, and A. D. Webb. 1982. The Technology of Wine Making, 4th Ed. AVI Publishing Co., Inc., Westport, Connecticut.
2. Ballinger, W. E., E. P. Maness, W. B. Nesbitt, D. J. Makus, and O. E. Carroll, Jr. 1974. A comparison of anthocyanins and wine color quality in black grapes of 39 clones of *Vitis rotundifolia* Michx. J. Amer. Soc. Hort. Sci. 99:338-341.
3. Bates, R. P. 1986. Cultivar evaulation for wine production, pp. 132-137. Proc. of the 9th Annu. Viticulture Sci. Symposium, Florida A & M University.
4. Bates, R. P., R. Tejada, and J. A. Mortensen. 1986. Effect of bunch and muscadine grape maturity on finished wine. Proc. Fla. State Hort. Soc. 99:194-200.
5. Burgess, J. 1986. Florida wine varieties: Now and in the future, pp. 93-97. Proc. of the 1st Greater Grapes Symposium, University of Florida.

6. Elmstrom, G. W. 1983. 50th anniversity ARC Leesburg Fla. HortScience 18:792, 1011.
7. Mortensen, J. A. 1986. Grape varieties, rootstocks, and propogation, pp. 13-25. Proc. of the 9th Annu. Viticulture Sci. Symposium, Florida A & M University.
8. Mortensen, J. A. and J. W. Harris. 1988. Muscadine and bunch grape fresh fruit taste panels during 21 years with 101 cultivars. Proc. Fla. State Hort. Soc. 101:229-232.
9. Sims, C. A. and J. R. Morris. 1984. Effects of pH, sulfur dioxide, storage time, and temperature on the color and stability of red muscadine grape wine. Amer. J. Enol. Vitic. 35:35-39.

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IN VITRO MICROPROPAGATION AND PLANT ESTABLISHMENT OF 'BLANC DU BOIS' GRAPE

D. J. GRAY AND C. M. KLEIN
University of Florida, IFAS
Central Florida Research and Education Center
5336 University Avenue, Leesburg, FL 34748-8203

Additional index words. plant tissue culture, benzyladenine, cytokinin, kinetin, naphthaleneacetic acid, thidiazuron.

Abstract. **Methods to micropropagate 'Blanc du Bois', a Florida hybrid bunch grape (*Vitis* spp.), were developed. Fifty percent of shoot apex explants obtained from field-grown plants produced viable cultures. Of four medium salt formulations tested, Murashige and Skoog (MS) and C_2D (a modification of MS) produced the most shoots per cultured apex. Comparison of the effect of the cytokinins benzyladenine and thidiazuron on shoot production showed that all concentrations of each that were tested produced significantly more shoots per apex than no-cytokinin controls (4.0 and 4.3, respectively vs. 0.7) whereas the best level of kinetin (10μM) produced only 0.6. Although similar in overall response, shoots produced with benzyladenine were larger and more normal in appearance than those from thidiazuron, which were small and stunted. Both in vitro and in vivo rooting methods were examined. For in vitro rooting, shoots placed on medium containing 1μM naphthaleneacetic acid produced longer roots than those on unsupplemented medium, although the total number of shoots that rooted and the number of roots per shoot were statistically similar. In vivo rooting was accomplished by placing shoots directly into moist potting mix, with or without a commercial rooting powder pretreatment. Rooting powder significantly increased root number but not length. Overall, in vivo rooting percentage was greater than that obtained from in vitro. In vivo rooting was more efficient since vigorous, acclimated plants were produced in less time. Furthermore, a major in vitro manipulation was eliminated by in vivo rooting.**

'Blanc du Bois' is a new Florida hybrid bunch grape cultivar released by the University of Florida in 1987 (5). It produces a premium white wine that sets a new quality standard for this state. The wine potential shown by this grape has resulted in an increase in acreage and a shortage of plants. In vitro micropropagation can be used to produce plants at rates in excess of conventional propagation methods (1, 3). Micropropagation has successfully been demonstrated for many grape species, hybrids and cultivars, including several Florida bunch grape hybrids (2, 3). In this report, we adapt micropropagation technology to 'Blanc du Bois'.

Materials and Methods

Twenty shoot tips approximately 4 cm in length were excised from rapidly growing plants at the CFREC Leesburg experimental vineyard and placed between layers of moist paper towels. In the laboratory, shoot tips were further dissected to approximately 6 mm in length and all leaves and tendrils were removed, except for those very small appendages enclosing the shoot apical meristem. The shoot tips were surface sterilized for 2.5-3 min by agitation in 25% commercial bleach containing a drop of Triton X surfactant. The shoot tips were rinsed twice and stored in sterile distilled water. The apex of each shoot (approximately 1 mm in diameter) was micro-dissected and placed, cut surface down, on autoclaved C_2D medium (1), containing 5 μM benzyladenine (BA) as previously described (2, 3). Cultures were incubated at 25C with an 18 hr cool white fluorescent light/6 hr dark cycle. The percentage of shoot tips that remained contaminant-free and proliferated as adventitious bud cultures was determined after 6 weeks.

Apical meristems from these initial cultures were used as explants for experiments to evaluate the effects of various medium salt formulations on micropropagation. Medium salt formulae tested were: Murashige and Skoog (MS) (6), 1/2 MS, C_2D (1) and woody plant medium (WPM) (4). Each medium contained 5 μM BA, 0.7% agar and 3% sucrose. Twenty apices were placed, five to a plate, on each medium and incubated as described above. After 6 weeks, the resulting number of shoots produced per apex was determined and an additional sample of 20 apices was recultured on the same respective medium. This cycle was repeated 3 times. Shoot proliferation data for the 3 cycles was pooled in determining average proliferation rates.

Effect of various cytokinins at different concentrations was determined using MS medium. Cytokinins and concentrations tested were: 5, 10 and 20 μM BA; 10, 20 and 40 μM kinetin (Kin); and 0.5, 1 and 5 μM thidiazuron (TD). These differential activity ranges for each cytokinin were determined in previous experiments. A no-cytokinin control treatment was also included. Twenty apices obtained on MS medium with 5 μM BA were plated on each cytokinin-concentration treatment and the number of shoots produced per apex was determined after 6 weeks. The experiment was repeated 3 times as above.

In vivo rooting of shoots was compared with in vitro rooting. For in vivo rooting, shoots with four-to-six nodes were excised and placed either directly in Pro-mix com-

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