AN ABSTRACT OF THE THESIS OF

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Title: Descriptive Analysis of Pinot Noir Juice and Wine Qualities.

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The overall purpose of this study was to develop sensory evaluation methodology whereby wine quality can be predicted from juice quality. Descriptive analysis was used by a trained panel to describe Pinot noir juice and wine from three sources. From each source, one wine and four juice samples (a control and three treatments) were prepared. The following three treatments were applied to the crushed grapes prior to pressing the juice: freezing and thawing; skin contact with 250 ppm Pectinol VR (a pectinase); and skin contact with 250 ppm Rohapect D5L (another pectinase). The trained panel developed descriptive terminology which differed between Pinot noir juice and Pinot noir wine. The juice treatments created subtle, if any, aroma differences.

Treatment differences were evident in color, as measured by human perception and by instrumental measurement. Few characteristics of wine aroma and/or color correlated with juice aroma and/or color. Perceived color correlated well with Somer's color density measurement (the sum of the corrected absorbances at 420 and 520 nm.). Some of the same samples were evaluated by a wine industry panel. They appeared to disagree regarding the definition of varietal character. Further research utilizing grapes from many sources is necessary to determine whether Pinot noir wine quality can be predicted from Pinot noir juice quality.

Descriptive Analysis of Pinot Noir Juice and Wine Qualities

by

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I. INTRODUCTION

It is generally accepted in the wine industry that grape quality is critical to wine quality. Grapes from separate locations and raised under different growing conditions, may not make comparable wines, even when harvested at the same Brix and total acid levels and processed under identical conditions in the winery. Their "perceived qualities" or "sensory attributes" may differ.

Decisions such as time of harvest, grape purchase price, and the optimum combination of grapes from different sources, need to be based on some criteria. Because these decisions must be made prior to making the wine, one must develop methods for predicting wine quality by evaluating juice quality.

In some grape varieties, the same aroma characters present in the grapes are present in the wine. This is not known to be true for Pinot noir. The distinct varietal character of Pinot noir is believed to develop during fermentation on the skins. In research on kiwifruit wine, commercial enzyme preparations appeared to be responsible for the development of an intense "fruity, Riesling Sylvaner (Muller-Thurgau)-type" aroma during fermentation (Heatherbell et al., 1980). Therefore, it seems possible that Pinot noir juice treated with enzyme preparations during skin contact may approximate "varietal character" in the finished wine.

There are seven objectives of this research: (a) to train a panel to develop Pinot noir aroma terminology; (b) to use descriptive analysis to quantify descriptive characters (attributes) for Pinot noir juice and wine; (c) to determine whether enzyme-treated Pinot noir juices differ significantly from control in aroma and/or in color; (d) to correlate Pinot noir juice descriptors with wine descriptors with the aim of predicting a wine profile from a juice profile; (e) to determine whether the chemical measurement of color parameters correlates with perceived color; (f) to use an untrained panel comprised of wine industry personnel to describe Pinot noir juice, wine, and must qualities; and (g) to compare industry descriptive data with trained panel descriptive data.

II. LITERATURE REVIEW

2.1 Juice/Wine Quality Assessment

Chemical

There have been numerous attempts to develop chemical maturity indexes for grapes based on sugar content, acidity, and pH. Ough and Singleton (1968) reported a significant correlation between the Brix/acid ratio of grape juice and wine quality for White Riesling and Cabernet Sauvignon. Coombe *et al*. (1980) proposed a new ripeness ratio, Brix X pH^2, based on data collected from an Australian wine Industry survey. This index was adopted but was later rejected by Cootes *et al*. (1981), and was replaced by appropriate ^{o}Be and pH ranges for dry red and dry white table wines. Berg and Ough (1977) established minimum, maximum, and base (ideal ripeness) degrees Balling (^{o}Be) for ripeness standards in red and white varieties. Somers (1975, cited in Cootes *et al*., 1981) pointed out the association between poor quality and high pH in red wines from warmer climates. Helm (1981, cited in Cootes *et al*., 1981) suggested that grape juice pH has been over emphasized as a measure of grape maturity in cool climates, and that titratable acid is a more useful guide. Amerine *et al*. (1980) developed the use of ^{o}Brix ranges and ^{o}Brix/acid ratios as quality parameters to determine picking maturity. Heatherbell

(1983) reviewed wine grape maturity and wine grape quality standards from other countries of interest to Oregon.

Sensory

The above chemical methods, unfortunately, do not always correlate with flavor. Researchers are beginning to report that the traditional chemical analyses used to assess grape quality indicate a wide range within which high quality wine can be made. Accordingly, sensory evaluation is an area of increasing interest in the evaluation of grape and wine quality.

A quality assessment scheme in South Australia pays a bonus percentage of up to 40 percent for varietal aroma and taste character (Cootes et al., 1981; Cootes, 1984; and Jordan and Croser, 1984). In the Grape Quality Assessment (GQA) scheme used in 1981, freshly pressed juice was treated with sodium metabisulphite, sodium erythorbate, and a pectic enzyme preparation. It was then centrifuged and the supernatant was pipetted into tasting glasses for sensory evaluation by four winemakers. A high correlation (r=0.96) was found between grape juice flavor and wine quality in Barossa Valley and Barossa Ranges Riesling. The authors, Cootes et al. (1981) also reported that Cabernet Sauvignon grape juice was an easy variety to assess because it has a distinctive "herbaceous" or "green pepper" character at ripeness. Under the GQA scheme, bonus points were assigned for the following categories: (a) aroma and taste of the grape juice (40%); (b) altitude of the vineyard (20%); (c) chemical analysis, degrees baume (15%), titratable acidity (5%), and pH (5%); (d) Physical condition of the grape sample, defects and material other than grapes (10%); (e) sulfur dioxide content of the grape sample (5%). Later, Cootes (1984), reported the changes to the original GQA system. Essentially, no changes were reported in the method of evaluating grape juice flavor or to the bonus percentage points for this category (40%). There were five categories for the respective aroma/flavor bonus percentage points: rich, distinctive varietal aroma and taste (30-40); distinctive varietal aroma and taste (20-29); slight varietal aroma and taste (10-19); neutral grape juice (0-9); and spoiled character (0).

Jordan and Croser (1984), assert that the GQA scheme can assist in determining picking date. The method of juice extraction was carefully considered in order to minimize enzymatic oxidation, which produces dank grassy aromas that mask fruit characters and make aroma evaluation difficult. There are two aims of the aroma/flavor assessment of juice: first, to monitor aroma intensity as the berries mature, and second, to monitor the quality of fruit character. The latter employs a limited vocabulary established according to the winemakers perception of varietal aromas. Sample terminologies were shown for different varieties as well as a correlation of juice aroma with wine quality for Sauvignon blanc. Triangle tests were employed to determine whether the intensity of fruit character was increasing or decreasing. Pinot noir was not evaluated in the GQA scheme.

2.2 Flavor Chemistry

Williams (1978; 1982) and Schreier et al. (1976; Schreier, 1979) reviewed the considerable advances in the knowledge of wine aroma compounds which have been separated by gas chromatography (GC). When dealing with the chemistry of wine aroma, Rapp and Mandery (1986) made the distinctions between the following: (a) the aroma which originated from the grape; (b) the aroma produced by fermentation; and (c) the bouquet resulting from the aging process.

Williams et al. (1983, cited in Jordan and Croser, 1984) studied the chemistry of aroma compound formation in muscat varieties. Gunata et al. (1985) stated that bound terpenols, located mainly in the grape skins of Muscat varieties, have considerable aroma potential which would be interesting to make use of in new wine technology. Jordan and Croser (1984), cited that other aroma compounds have been found in the following nonmuscat varieties: Cabernet Sauvignon (Bayonove *et al*. 1975), Chenin Blanc (Augustyn and Rapp 1982), and in Sauvignon Blanc (Augustyn *et al*. 1982). Volatile flavor components have also been identified for commercial port wines by Williams *et al*. (1983), and for Cabernet Sauvignon by Slingsby *et al*. (1980).

Aroma is a complex property. Jordan and Croser (1984) state that not all volatiles are odorous, and the overall mixture of the aroma compounds is not perceived as the sum of individual aromas because the compounds have synergistic and masking effects on one another. Therefore, it is necessary to understand the combinations of compounds that approximate perceived aromas.

2.3 Sensory Significance of Chemical Data

Panels trained in sensory evaluation are required in wine aroma research in order to interpret the significance of the chemical data. Williams (1978a-c) reviewed the interpretation of the sensory significance of the chemical data in flavor research. Jounela-Eriksson (1983) reviewed the evaluation of flavor in beer, wine and distilled alcoholic beverages. Noble *et al*. (1980), selected sensorially significant components by sniffing the aromas of GC-effluent from wine headspace analysis.

2.4 Descriptive Analysis

Stone et al. (1974) described Quantitative descriptive analysis. Civille and Lawless (1986) emphasized the importance of language in describing perception. Lehrer (1975) examined wine vocabulary from a linguistic point of view. Noble (1984; Noble et al. 1983) stressed the merits of descriptive terminology for the purpose of precise communication and quantification in wines. Standardized flavor terminology has been developed for many industries including the following: the brewing industry (Meilgaard et al., 1979; Clapperton, 1973; Mecredy et al., 1974), the wiskey industry (Piggott and Jardine, 1979), and cider (Williams, 1975; Williams and Carter, 1977). Williams and Langron (1984) described and approach to profile analysis in which each assessor produces individual profiles of the products, using his or her own terms for describing them. Herraiz and Cabezudo (1980/81) proposed two analytical ways to define the quality of wines using sensory profiling. Vocabulary for profiling specific wines was developed for Zinfandel by Noble and Shannon (1987), and for Cabernet Sauvignon by Heymann and Noble (1987). McDaniel (1986; 1987; McDaniel et al., 1987 in manuscript) used descriptive vocabulary to evaluate Pinot noir wines fermented with different strains of malolactic bacteria.

Although research has been published on the relationship between juice and wine qualities for some grape varieties, and on descriptive analysis of Pinot noir wine, no studies were found concerning the relationship between the sensory qualities of Pinot noir juice and wine, nor any describing the chemical compound(s) responsible for Pinot noir varietal character.

2.5 Color

Color has been evaluated as a quality parameter in red wines by Timberlake (1981), Jackson et al. (1978), Timberlake et al. (1978), and Somers and Evans (1977). Kerenyi and Kampis (1984) compared the sensorially established and instrumentally measured color of red wine and found that plotting the sum of light absorption values as measured at 420 and 520 nm (value $E_{420+520}$) as a function of the average sensory values for color intensity, a homogeneous linear correlation was established with a correlation coefficient above 0.9. Increased skin contact time is known to increase the extraction of anthocyanins for color, and tannins for flavor (Schmidt and Noble, 1983). The use of pectic enzymes has been shown to increase color extraction (Flores, 1983; Flores and Heatherbell, 1984; and Ough et *al*. 1975).

III. METHODS

3.1 Sample Preparation

Juice Samples

One hundred thirty six kilograms each of the following grapes were harvested in September of 1983: Pinot noir from Corvallis, Pinot noir from Medford, and Gamay Beaujolais from Corvallis. Each lot was stemmed, crushed, mixed, and divided. Seventy two kilograms of each harvest was divided into four batches (18 kilograms each) for different experimental treatments.

The treatments applied to the crushed grapes were as follows:

1. freezing and holding at $-17^{o}C$ for 24 hours then thawing in a warm water bath for approximately 4 1/2 hours until the product reached room temperature.

2. skin contact alone (control) for 24 hours.

3. skin contact with 250 ppm Pectinol VR, Rohm Tech, Inc., New York, NY, (a pectolytic enzyme preparation which also has mucolytic activity) for 24 hours.

4. skin contact with 250 ppm Rohapect D5L, Rohm Tech, Inc., New York, NY (a pectinase) for 24 hours.

Skin contact for all treatments occurred in an 18-$20^{o}C$ room. Juice was pressed manually using a horizontal basket press. The Corvallis Pinot noir and the Corvallis Gamay Beaujolais juices were treated with 20 ppm SO_2, held at 3.3^{o}C for two days, racked once, transfered to half-gallon wide-mouth glass jars (half full) and gallon wide-mouth glass jars (three quarter full), then frozen at -17^{o}C. The Medford Pinot noir was pressed, treated with 20 ppm SO_2, and bottled in glass fifths. It was then mistakenly left at room temperature (approximately 22^{o}C) for two days, after which it was held in cold storage (3.3^{o}C) for one day. Evaluation by the Oregon State University Department of Food Science and Technology's enologist revealed slight wild yeast and slight acetobacter odors and no unusual flavors. The juice was believed to have undergone only minimal change resulting from the time period without refrigeration and was therefore used in the study as one of the three sources. The juice samples were then racked, retreated with 20 ppm SO_2, transferred to glass fifths (approximately three quarters full), frozen, and stored at -17^{o}C.

Wine Samples

One hundred thirty six kilograms of each of the above harvests went through standard processing and vinefication techniques at The Oregon State University Department of Food Science Pilot Plant Experimental Winery. Wines were stored in glass.

Must Samples

In September of 1984, two must samples were taken during the fermentation of the Pinot noir grapes harvested in Corvallis. Samples were taken after 24 hours and 48 hours of fermentation and placed in 946 ml. bottles. They were kept frozen at -17°C for subsequent evaluation. One day prior to the first evaluation, the samples were thawed at 0°C. The thawed samples were racked and transferred into 30 ml. screw-top jars, flushed with nitrogen before sealing, and held at 0°C overnight for the industry panel.

3.2 Panel Selection

Twenty-one volunteers from a university setting with an interest in wine were tested for normal sensory taste acuity. They ranked taste intensities of solutions of sucrose, tartaric acid, sodium chloride, caffeine, and ethanol (alone and in combination) in water and then in a base wine. Panel selection was based on normal sensory acuity, interest, availability, and consistant attendance at training sessions. Fourteen panelists were selected. Seven were male and seven were female. Panelists' ages ranged from 20 to 40 years.

3.3 Panel Training and Ballot Development

Twelve of the selected panelists had recently been trained for a study evaluating Pinot noir wine fermented by six malo-lactic strains (McDaniel et al., in manuscript). This training gave panelists the opportunity to become familiar with Pinot noir wine attributes and their descriptive terms.

Juice Aroma

The Wine Aroma Wheel, as developed by Noble et al. (1984), was used to begin generating a vocabulary of descriptive terms for Pinot noir juice. Panelists were given two juice samples and asked to generate terms by concentrating on aroma first and then flavor-by-mouth. To reduce inhibition, panelists were encouraged to list everything that came to mind. Panelists were seated around a table, working first independently and then sharing in group discussion. After two sessions, it was found that the same terms were used to describe flavor-by-mouth and aroma.

The panelists found that sweetness overpowered the perception of sourness. Neither bitterness nor astringency were noticed as had been expected. Enzymes are believed to increase extraction of phenols, tannins, and pigments, which are reported to be both astringent and bitter (Singleton and Noble, 1976; Arnold and Noble, 1978; and Singleton and Esau, 1969). Because no additional information was generated from flavor-by-mouth, the decision was made to look at aroma only.

A three-tier training ballot using most of the previously generated terms was created to rate aroma intensity on a scale of one to nine (1 = none, 9 = extreme) (Appendix). The most general characteristics, for example "fruity", were referred to as first-tier terms. More specific are the second-tier terms, such as "berry," "tree fruit," or "dried fruit." Most specific are the third-tier terms, such as "cherry" or "prune." In evaluating a sample, if a panelist detected a fruity character (first tier), overall fruity character intensity was rated. Further, if the panelist determined the fruitiness to be a cherry note, both cherry (third tier) and tree fruit (second tier) were rated. The panelist always rated the first-tier character equal to or higher in intensity than the more specific second- and third-tier terms. For evaluation, 30 ml. of each experimental juice was poured into a 12 ounce red glass and covered by a watch glass. During ballot development, aroma standards (or references) were used to define terms (Appendix).

Juice Color

One hundred twenty ml. of each sample were placed in a clear plastic, rectangular container with a one inch pathlength. The lighting source was a MacBeth Executive on daylight setting. Training for color evaluation consisted of two practice sessions. Magnitude estimation (Stevens, 1946) was the scaling method used by the panel to evaluate color intensity and browning. An internal reference was given the value of 50. The method of magnitude estimation is based on ratio properties. If the sample were three times as intense as the reference, then a value of 150 (50 X 3) was assigned. If the sample were one half as intense then a value of 25 (50 / 2) was assigned and so forth. Panel discussion revealed confusion over color intensity and darkness. It was decided that darkness (or degree of darkness) was the best understood word to represent color intensity. Darkness was defined as a measure of how much light can pass through the sample. A high value reflected a sample with a high degree of darkness or opacity where minimal light passes through. A low value reflects a sample where more light passes through. The magnitude estimation data from the training sessions correlated well with analytical measures for color intensity (darkness) but not for browning. Therefore browning was eliminated.

Wine Aroma

Training for the wine aroma evaluation consisted of more term generation using the wine aroma wheel and the references previously selected for the Pinot noir juice. Standards, or references (Appendix), were added and deleted as needed to clarify definitions of aroma descriptors. A similar three-tier ballot was created using many terms. In three sessions, the frequency of descriptor use was compiled and some terms were deleted.

Wine Color

No additional training was conducted for wine color evaluation. It was decided to handle the wine evaluation in a manner similar to the juice evaluation.

3.4 Experimental Procedure: Trained Panel

Juice Aroma Evaluation

In a total of nine sessions, the panelists evaluated the juice samples in triplicate. At each session, the panel received a set which contained all four treatments from one source. Set order was randomized as was the order of samples on each tray. Each sample was coded with a 3-digit random number.

For aroma evaluation, panelists were seated in individual testing booths with red lighting, and were provided with a ballot (Appendix) and a tray containing four red glasses, each covered by a watch glass. Each glass contained 30 ml. of juice at room temperature (approximately 18°C). The aroma references were available at each session for panelists to review if desired (Appendix).

Juice Color Evaluation

Color and aroma evaluation occurred during the same testing sessions. Color was evaluated under daylight in the MacBeth Executive. Juice samples were filtered (0.45 millimicron pore size) and 120 ml. were placed in rectangular, clear plastic boxes with one inch pathlengths. An internal reference (Corvallis Pinot noir control) was used throughout the study. It was selected for use as the reference because it was judged by the experimentors to be midrange for darkness. Presentation order was randomized and samples were coded with 3-digit random numbers. A magnitude estimation ballot was used (Appendix) with the reference darkness intensity value set at 50.

Wine Aroma Evaluation

In three additional sessions, wine aroma was evaluated in the same manner as was juice aroma. Each of the three wines were evaluated at each session. Thus, the experiment was done in triplicate. A different but similar ballot was used (Appendix).

Wine Color Evaluation

Wine color and aroma were evaluated during the same three sessions. Wine darkness was evaluated in the same manner as was juice darkness. The same reference used for juice was also used for the wine evaluation.

3.5 Experimental Procedure: Industry Panel

Industry panel data was collected during a workshop on "Sensory Evaluation of Wine." The panel consisted of wine industry personnel including grape growers and wine makers. Samples were set up in a section of a room which was being used for independent learning (examples of wine defects etc.). Participants were asked to participate in the following two tests: juice/wine aroma and color evaluation; and must/wine aroma evaluation.

Juice/Wine Aroma and Color Evaluation

The first industry test evaluated the four juice treatments and finished wine from 1983 Pinot noir grapes from Corvallis. Samples (30 ml.) for aroma evaluation were given 3-digit random codes and placed in 12 ounce brown glasses which were then covered with foil. Samples (120 ml.) for color evaluation were coded and placed in clear plastic containers with a one inch pathlength under daylight in a MacBeth Executive. On the ballot (Appendix), participants were asked to rate the intensity of each attribute on a scale of 1 to 9 (1 = low, 9 = high) for varietal character, overall aroma, and color intensity.

Must/Wine Aroma Evaluation

The second industry test involved the evaluation of must and wine from 1984 Pinot noir grapes from Corvallis. The must samples had been collected after 24 and 48 hours of fermentation and stored frozen until the test. Must sample quantity was limited, and therefore each participant could not have his/her own set (some sets were evaluated more than once). Also, because the product was unstable at room temperature, exposure time was limited. Each hour (three total) new samples were brought from cold storage, 30 ml. poured into a brown 12 ounce glass, and covered with foil for evaluation. On a ballot (Appendix), participants were asked to rate varietal character and overall aroma intensity on a scale of 1 to 9 (1 = low, 9 = high).

3.6 Chemical Analysis of Samples

Soluble Solids

Soluble solids (^{o}Brix) determinations were made in duplicate on the juice samples at 20^{o}C with a bench-top, Baush and Lomb refractometer. Temperature corrections are described in the AOAC (12th Ed.).

Total Titratable Acidity

Total titratable acidity was measured on 5 ml. of Pinot noir juice combined with 100 ml. of distilled water and titrated to pH 8.2 with 0.1 NaOH. Total acidity was expressed as g/100 ml. tartaric acid.

pH

Measurements of pH were carried out using a Corning pH meter 125 at 39^{o}C.

Anthocyanin Pigment Content

Anthocyanin pigment content was determined on the juice samples by the pH differential method reported by Wrolstad (1976). The anthocyanin concentrations, expressed as mg./L juice, were based on malvadin-3-glucoside with a molecular weight of 493.5 and a molar absorptivity of 28,000.

Measurement of Color Parameters

Color density, polymeric color, percent polymeric color, and browning index were measured using the Somer's potassium metabisulfite method reported by Wrolstad (1976). Color density, the sum of absorbances at 420 and 510 nm., give a measure of the total sample color. Polymeric color is the sum of the absorbances at 420 and 510 nm. of the bisulfite treated samples. Percent polymeric color is defined as the percent ratio of polymeric color to that of color density. The browning index was determined from the absorbance at 420 nm. of the bisulfite treated sample.

Hunter "L" was measured in the transmission mode using a Hunter Model D 25 P-2 Color Difference Meter, which was standardized against a white tile (No. DC 122, L=+94.02, a=-0.9, b=$\pm$1.2). All measurements were made with the light source in the normal, aligned position (Arrangement I) for the diffuse transmittance only, excluding the specular component.

Total Phenolics

Total phenolics were determined using a method described by Amerine and Ough (1974). Folin-Ciocalteau reagent and Na_2CO_3 (75g/L) solution were utilized. Optical density (OD) was read at 765 nm. The total phenolic content was calculated as gallic acid equivalents (GAE).

3.7 Statistical Procedure

Trained Panel: Aroma Data

Screening. After the data collection, the frequency of term usage on the ballots was tallied. If a term were not used (rated 1 = none) at least 60% of the time, that term was eliminated from the analysis. In other words, if the term were used more than 40% of the time it was included and further analysed. See Table 1 for the frequency of descriptor use.

The assumption was made that for each attribute, the group consensus was correct. Any panelist differing from the group consenus was not performing well and should be eliminated. Therefore, to screen panelists for performance, a pooled correlation coefficient was applied to the remaining terms to correlate each panelist with the group (the other 13 panelists). This procedure was carried out term by term with the belief that each panelist may not have been able to perform at the same level for each descriptive term. See Table 2 for the correlation coefficients.

To carry out the pooled correlation coefficient procedure on the juice data for the four treatments, the sum of squares for X (panelist), the sum of squares for Y (average of other panelists), and the cross products of X and Y for each of the nine data sets (three replications and three sources) were calculated. The nine sets were then pooled by adding all the sums of squares and cross products for X, Y, and XY, and then these values used in the correlation formula (sum of cross products divided by the square root of the product of two sums of squares). Using this pooling method, there were 18 degrees of freedom (d.f.).

Subsequently, any panelist with a pooled correlation coefficient of less than -0.20 was eliminated from the data for that descriptive term. It was estimated that this "ad hoc" procedure would eliminate the lowest 10% of the data (therefore eliminating the lower tail). It was also believed that with 18 d.f., eliminating values below -0.20 would increase the probability that the true correlation coefficient is positive.

Analysis of Variance. After terms and panelists were screened, analysis of variance (ANOVA) was applied to the remaining juice aroma data. The interest was in the treatment effect, but because the treatments were fixed, and sources and panelists were random, there was no direct error term for testing signigicance of treatments. Therefore the F-test was obtained by using the method reported by Cochran and Cox (1957), where the mean square errors (MSE) were used in the following ratio equation: PST + T / PT + ST (where P=panelist, S=source, and T=treatment). Degrees of freedom (d.f.) were estimated by the Satterthwaite approximation in order to test the statistical significance. (Cochran and Cox, 1957).

Juice/Wine Correlations. In a separate analysis, the aroma data for juice was plotted against the wine aroma data. Each panelist-source combination was averaged over replications (1-3). The 14 panelists were pooled using the same method described to screen panelists (where X = juice data and Y = wine data). Fourteen d.f. were obtained by pooling panelists (14 X (3 - 2)). Panelists were pooled in order that the correlations would be due to "real material differences" (sources) rather than due to panelist variation. Each of the 17 chosen wine descriptors were plotted against each of the 11 chosen juice descriptors. Separate plots were completed for each of the four treatments (freeze, control, VR, D5L) generating a total of 748 correlation coefficients. Statistical significance levels were used to identify relationships between juice and wine description.

Trained Panel: Color Data

Magnitude Estimation. Magnitude estimation (Stevens, 1946) was the scaling method used for the darkness evaluation. An internal reference was given the value of 50. The data was normalized by computing the geometric mean for each panelist and dividing each individual raw data value by its respective geometric mean.

Analysis of Variance. ANOVA was then performed on the normalized data using the PST + T / PT + ST F-value as described above to test for treatment effect.

Juice/Wine Correlations. The normalized darkness means were also plotted in the same manner as the aroma means. Juice darkness was plotted against the 17 wine aroma attributes plus wine darkness. Wine darkness was plotted against the 11 juice aroma attributes plus juice darkness. One panelist had an incomplete data set and, therefore, was eliminated, leaving 13 panelists and 13 d.f. (13 X (3 - 2)).

Multiple Comparison. ANOVA was applied to the normalized darkness data. The treatment and the source-by-treatment interaction effects were found to be significant. Therefore, Tukey's (HSD) multiple comparison test was carried out.

Industry Panel

Juice/Wine Aroma and Color Evaluation. ANOVA was applied to the data. For varietal character, the panelist-by-treatment effect was significant. Therefore, multiple comparisons were not completed for this descriptor. For overall aroma, panelist and treatment effects were both significant while panelist-by-treatment effect was not significant. For color intensity, treatment effect was significant while both panelist and panelist-by-treatment effects were not significant. Therefore, Tukey's multiple comparison was applied to the data for overall aroma and color intensity.

Must/Wine Aroma Evaluation. ANOVA was applied to the data. For both varietal character and overall aroma the treatment effects were significant while the panelist and panelist-by-treatment effects were not. Tukey's multiple comparison was therefore also applied.

Chemical Analysis

ANOVA by source and treatment was carried out on the chemical analysis of the 12 juice samples. Source, treatment, and source by treatment effects were all significant for each analysis. Therefore, Tukey's multiple comparison test was applied to the data.

Sensory-Chemical Correlation

Juice darkness data generated by the trained panel (averaged over panelists and replications) was plotted against the chemical measurements (averaged over replications) for anthocyanin pigment, color density, polymeric color, percent polymeric color, browning, Hunter "L," and total phenolics. Correlation coefficients were calculated with ten d.f. and statistical significance determined to identify relationships between sensory and chemical measurement.

IV. RESULTS AND DISCUSSION

4.1 Screening

Descriptive Terminology

The first two objectives of this research were to train a panel to develop Pinot noir aroma terminology, and to use descriptive analysis to quantify descriptive characters (attributes) for Pinot noir juice and wine. After the panel was trained and the descriptive aroma intensity data had been collected, term usage was evaluated. Figure 1 contains the frequency of term usage for all the Pinot noir juice treatments.

Upon examination of these data, it was noted that some terms, even after being selected in the training process, were seldom used. The usage of the seldom-used terms was examined futher to see how it scattered among the treatments. The usage was evenly scattered, therefore, any term which was used less frequently than 40 percent of the time was eliminated. On the juice ballot, only 11 out of 25 terms were used frequently enough to analyse. For tier-one terms, the range of use varied from 27 to 100 percent, and four out of six terms were maintained for analysis. For tier-two terms, term use ranged from 31 to 85 percent, and four out of six terms were again kept for analysis. Because each tier was more specific than the previous, frequency of use decreased within each category as did the percentage of terms kept for analysis. For tier three, only three out of 13 terms were used frequently enough to remain after screening. Percent use of the third-tier terms ranged from 11 to 61.

It was of interest to examine term usage by tier. The general term "fruity" was used 96 percent of the time. Within the fruity category, the second tier terms "berry" (47%), "tree fruit" (85%), and "dried fruit" (78%) were retained. Within "berry," no third-tier terms were retained. "Apple juice" (61%) and "cherry" (51%) were retained as third-tier terms under tree fruit. The only third tier dried fruit term retained was "prune" (42%).

The terms "vegetative" (first tier), and "fresh vegetative" (second tier), were used with high frequency at 89 and 78 percent, respectively.

The term "sweet" (first tier) was used 82 percent of the time, but no more specific terms were retained.

Frequency of term usage for the three wines evaluated are shown on a Pinot noir wine ballot (Figure 2). Screening out wine terms having less than 40 percent usage decreased the number of terms retained for analysis from 47 to 17. Frequency of term use on the first tier ranged from 17 to 100 percent, and 8 out of 10 terms were kept for analysis. Second-tier terms ranged in frequency of use from 17 to 93 percent, and 7 out of 15 were retained. On the third tier only two out of a possible 22 terms, "black pepper" and "ethanol," were retained for analysis. Frequency of use for third-tier terms ranged from 5 to 93 percent.

The term "fruity" (first tier) was used 98 percent of the time. Second-tier terms, "citrus" (45%), "berry" (62%), "tree fruit" (49%), and "dried fruit" (71%) were used with enough frequency to retain. No third-tier fruity terms were retained for analysis.

The first-tier term, "vegetative," and the second-tier term, "canned/cooked vegetative" were retained for analysis.

"Chemical," "pungent," and "ethanol" were used at 96, 93, and 93 percent, respectively. As no other specific chemical notes were retained for analysis (e.g. "sulfur," 22%), and the difference from the first tier to the third tier was so small, it appears that "ethanol" is the term of interest rather than "chemical" or "pungent."

"Sweet" (76%) and "microbiological" (48%), both first-tier terms, were retained for analysis but no second-tier terms under them were retained for analysis.

Differences between descriptions of juice and wine can be noted in comparing the frequency of term usage on their respective ballots. For both juice and wine, "fruity" appears to be an important descriptor. "Berry" was used more frequently to describe wine (62%) than it was to describe juice (47%). "Tree fruit" was used more frequently to describe juice (85%) than to describe wine (49%). Third-tier terms, "cherry" (51%) and "apple juice " (61%) were rated more often in juice than even the second-tier term, "tree fruit," in wine. The term "dried fruit" was used with similar frequency (78 and 71%) on both the juice and wine ballots. However, in juice, "prune" was perceived more frequently than it was in wine. "Citrus" was perceived to be a descriptor in wine, but it did not even appear on the juice ballot.

"Floral," "spicy," and "microbiological," and their second- and third-tier terms selected by the panel for Pinot noir wine description, were not selected for juice description.

"Chemical" appeared on both the juice and wine ballots, but was only used with high enough frequency on the wine ballots to be retained for analysis. It appears that this difference in use was due to the ethanol present in the wine.

Vegetative descriptors appeared to be used frequently for both juice and wine (89% and 71% respectively). However, there was an important difference at the second-tier level where "fresh vegetative" was used 78% of the time to describe juice and only 17% to describe wine. Canned/cooked vegetative characters were rated in wine 40% of the time but in juice this character was not even selected by the panel for rating.

Trained Panel

After screening terms, panelist performance was evaluated. Panelist performance was evaluated for the juice aroma data and panelists with substandard performance ($r < -0.20$) were eliminated. Table 1 contains the pooled correlation coefficients used to screen panelist performance. The number of panelists eliminated per descriptor ranged from zero to five. Some correlation coefficients were not estimable due to lack of variation in panelist replication. Because it was impossible to evaluate the performance of these panelists, they were also eliminated from the subsequent analysis.

The following panelists were below the established standard and therefore eliminated from subsequent evaluation for the following terms: overall aroma intensity, panelist 12; "fruity," panelists four, six, and 13; "tree fruit", panelist 13; "cherry," panelists two and 11, "apple juice," panelist 14; "dried fruit," panelist two; and "sweet," panelists one, four, six, nine, and 14. The terms "vegetative" and "fresh vegetative" must have been rated consistently by all panelists as none were eliminated from the analysis. The terms "berry" and "prune" had no panelists eliminated on the basis of poor correlations, but two were eliminated from "prune" and one from "berry" for data which was not estimable. Because five out of 14 panelists were eliminated from "sweet" it seems reasonable to suspect poorer agreement among the panel regarding this term.

Using this method of screening, approximately 9 percent of the panelists were eliminated. No panelist was eliminated more than twice for poor correlations. Five panelists were eliminated twice, four panelists were eliminated once, and five panelists did not have any poor correlations. It would appear from this information that the panelists were equivalent in their ability to use descriptors to rate Pinot noir.

4.2 Enzyme Treatments

The third objective was to determine whether enzyme treated Pinot noir juices were significantly different from the control juice in aroma and/or in color. Table 2 contains mean intensity ratings for juice aroma and darkness. This table also contains contrasts of the control against the other treatments for the purpose of showing statistically significant differences. In sensory evaluation there is interest in a panelist-by-treatment effect. When a panelist-by-treatment interaction occurs, the analysis usually ends without the ability to test for treatment effect. Using this method as described in the methods section, above, even if there is a panelist-by-treatment interaction (indicating disagreement among panelists in regard to the treatments), a significant treatment effect would indicate an effect above and beyond that disagreement.

Aroma

For most of the aroma descriptors there were no significant differences between the control and the treatments. There was strong evidence ($P < 0.01$) to suggest a significant difference in the vegetative aroma between the control and the freeze treatment, and slight evidence ($P < 0.05$) to suggest a significant difference between the control and the D5L enzyme treatment. The mean intensity ratings for vegetative character were higher for the freeze treatment than for the control. The mean intensity scores for vegetative aroma of both enzyme treatments were 3.03 and 3.08 for VR and D5L, respectively. Yet this analysis showed statistical significance between means 3.08 (D5L) and 3.39 (control), but not between 3.03 (VR) and 3.39 (control). Each contrast was tested against its own sources of error rather than the pooled mean squares over all treatments. Since the VR versus control contrast had a higher mean square for its interaction with source, the VR versus control contrast was not significant at the 0.05 level whereas the D5L versus control contrast was. There also was a significant difference between the control and the freeze treatment for the sweet aroma intensity, but not between the control and the enzyme treatments. It can be said, then, that the differences among the control and the other three treatments are minimal for all descriptors except "vegetative." Therefore, if any one aroma descriptor for a juice treatment is a better predictor than the control, then "vegetative" should be studied more closely. "Vegetative" was also one of the few terms on which all panelists appeared to be consistent and for which all were retained for the analysis of variance.

Darkness

In the darkness contrasts for control versus the other treatments (Table 2), there was strong evidence ($P < 0.01$) to suggest that the control was significantly different in darkness intensity than each of the three treatments. The mean magnitude estimate of darkness for the freeze treatment was lower than the control. Both Brown (1975) and Flora (1976), stated that freezing crushed grapes for later use resulted in increased pigment extraction. It appears that the observed color decrease in this study is due to a decrease in skin contact time at room temperature rather than the result of freezing. Both of the enzyme treatments had higher mean magnitude estimates, suggesting that more color was extracted by the enzyme treatments. Flores and Heatherbell (1984) found greater "apparent color intensity" in enzyme treated strawberry juice.

In a more detailed look at darkness, Table 3 contains multiple comparisons of the mean magnitude estimates of darkness of experimental juice and wine. This analyis supports the results of the previous darkness analysis. The enzyme treatments were significantly darker than the control and freeze treatments, both within and across sources. There was no significant difference found among sources for the juice. However, in the wine, the Pinot noir from Medford was significantly lower in darkness than either of the wines originating in Corvallis. This could be due to different growing conditions. The fact that the difference was perceived in the wine and not in the juice could be due to the extraction of pigments from the grape skins in the presence of alcohol during fermentation of the wine.

One must be very careful in comparing the juice to the wine darkness data. As these were not rated at the same time, the mean magnitude estimates are relative only to the reference. The reference was the same for the juice as well as for the wine evaluation, but the scores were not the same after the data was normalized.

4.3 Juice/Wine Correlations

The fourth objective of this research was to correlate Pinot noir juice descriptors with wine descriptors with the aim of predicting a wine profile from a juice profile. Table 4 contains the statistical significance levels from correlation analysis for descriptor intensity ratings of juice versus wine. Separate correlations were done for each of the treatments to determine whether any of them could induce a better correlation.

A total of nine out of 864 possible significant correlations were found. The distribution among juice treatments where significant correlations were found was the following: five from control; three from freeze; and one from D5L. It does not appear that the enzyme treatments induced a better correlation between juice and wine descriptors. With so few correlations, it is inappropriate to speculate further.

The only descriptor for which significant differences were found among treatments was "vegetative." No correlation was found between "vegetative" in juice and any wine descriptor.

"Berry" in juice (control) correlated negatively with "dried fruit" in wine. The second- and respective third-tier terms, "tree fruit," "cherry," and "apple juice," correlated with the following five wine descriptors: "tree fruit" in juice (control) correlated negatively with "tree fruit" in wine; "tree fruit" in juice (freeze) correlated positively with both "spicy" and "black pepper" in wine; "cherry" in juice (freeze) correlated positively with "black pepper" in wine; and "apple juice" character in the control juice correlated negatively with "tree fruit" in wine. "Dried fruit" in juice (control) correlated positively with wine "darkness." "Prune" in juice (control) correlated negatively with "tree fruit" in wine. Juice "darkness" (D5L treatment) correlated negatively with "tree fruit" in wine.

For each juice descriptor versus wine descriptor correlation, there were four correlation coefficients calculated (one for each juice treatment). The logic follows, then, that if no one treatment correlated more often than any other treatment, the four treatments could be considered as additional observations. It would then be reasonable to infer that the more times a statistically significant correlation is found, the more evidence there would be to support the idea that an actual correlation existed between the juice and the wine descriptors. A statistically significant correlation was not ever found more than once out of the four treatments. Therefore, there is no good evidence to suggest that any relationships exist between the juice and the wine descriptors for the experimental samples studied.

4.4 Chemical/Sensory Correlations

The fifth research objective was to determine whether chemical measurement of color parameters correlate with perceived color.

Table 5 contains degree brix, titratable acidity, and pH measurements of the juice. These measurements appeared to be very similar among treatments. The focus of this research was not to make prediction of wine quality based on these parameters. This focus has been addressed by others and has been reviewed earlier in this thesis. The following measurements were made on the finished wine: Pinot noir-Corvallis, 0.60 g./100 ml. titratable acid (T.A.) expressed as tartrate, 3.57 pH, 11.4 percent alcohol (V/V), 1,016 mg./L GAE (phenolics are expressed as gallic acid eqivalents), and 382 mg./L anthocyanins; Pinot noir-Medford, 0.53 g./ 100 ml. T.A., 3.53 pH, 11.3 percent alcohol, 737 mg./L GAE, and 251 mg./L anthocyanin; and Gamay Beaujolais-Corvallis, 0.53 mg./100 ml. T.A., 3.49 pH, 11.3 percent alcohol, 976 mg./L GAE, and 368 mg./L anthocyanin.

Table 6 contains chemical measurements of the color parameters of the twelve Pinot noir juice samples. Table 7 contains the correlation coefficients of sensory darkness versus chemical analysis of juice.

Anthocyanin pigment (monomeric color) tended to be higher in the enzyme treated juices, with one exception, the Pinot noir control from Medford. There are many factors which affect available or extractable color, such as variable pressure during juice pressing, or even varying grape skin thickness. It is difficult to speculate why the control treatment from Medford was higher than the enzyme treatments when the two control treatments from Corvallis were not. Anthocyanin pigment did not correlate with "perceived" darkness intensity. Monomeric color actually represents potential color, which is not always seen. Therefore, the lack of correlation with perceived color is not surprising.

Color density appeared to be higher in the enzyme treated samples and lower in the sample that was frozen prior to pressing when compared to the control within each source. This data correlated very well with the sensory data ($P < 0.01$). This analysis must be a good indicator of what the trained panel was measuring as "degree of darkness" or "darkness intensity." This correlation is in agreement with the research of Kerenyi and Kampis (1984), which was reviewed earlier in this thesis.

Polymeric color tended to be higher in the enzyme treatments again, with a few exceptions. The Pinot noir control from Corvallis was higher than the enzyme treatments. This was the same exception that was seen in the anthocyanin analysis. Polymeric color also correlated with the panel data. None of the correlations were as strong as that for color density.

Percent polymeric color and total phenolic data did not correlate with the panel.

The enzyme treatments tended to be higher for the browning index measurements, with the same exception seen for anthocyanin and polymeric color (Pinot noir-Corvallis control). The browning index correlated with the sensory panel.

Hunter "L" data correlated with the panel data. The general pattern was that enzyme treatments had higher values (or more lightness). The measurement for the Pinot noir control from Medford was quite low compared with all others. And the Pinot noir control from Corvallis was, once again, an exception.

Perceived color is the combination of many different parameters. It is essential when trying to correlate sensory and chemical parameters that each be well defined. In sensory evaluation, the communication of color, as with aroma, relies heavily on descriptive terminology. Precise communication using color terminology is difficult. A major challenge lies in the panelist's understanding of the descriptive terminology.

4.5 Industry Panel

The last two research objectives were to use an untrained panel comprised of wine industry personnel to describe Pinot noir juice, wine, and must qualities, and to compare wine industry panel descriptive data with trained panel descriptive data. Tables 8 and 9 both contain means and multiple comparisons of intensity ratings by members of the wine industry.

A different ballot was used for the wine industry panel. The ballot was shorter and the terms differed. The terms selected were terms commonly used by winemakers. Both panels rated "overall" aroma intensity. The industry panel rated "varietal character" intensity rather than the many different descriptors that the trained panel rated. Color was described as "color intensity" for the industry panel and as "darkness" for the trained panel. Refer to Appendix for sample ballot.

"Varietal character" is of great importance to the wine industry. Yet the term is difficult to define, or at least is not consistent in its definition. Table 8 contains the wine industry evaluation of the 1983 Pinot noir juice treatments and wine (aged over 2 1/2 years). In the statistical analysis, a significant panelist-by-treatment interaction was found. This type of interaction generally indicates that panelists are not evaluating the material in the same way or that there is lack of agreement. Because of the high panelist-by-treatment interaction, a significant difference in treatment effect was not detected.

Multiple comparisons of the overall aroma data, rated in the same test, indicated that all juice treatments were significantly different from the wine. The juice was perceived to be lower in overall aroma than the wine.

Evaluation of color intensity indicated that the enzyme treatments were significantly higher than the control and freeze treatments. Further, the freeze treatment was rated as significantly lower than the control. The color intensity in the wine was rated lower than the juice treatments, but was not significantly different from the freeze treatment. In comparing these data (Table 8) to the trained panel data for darkness (Table 3), it would appear that the trained panel rated darkness intensity higher in the wine than in the juice. It is important to note that the ballot asked different questions. The wine industry panel rated "color intensity" on a scale of one to nine (where 1 = low intensity, and 9 = high intensity). The trained panel evaluated "darkness" by magnitude estimation. The scales were different and, also, the panelists' definitions of "color intensity" and "darkness," were not likely to be the same. This kind of comparison is difficult to make.

Multiple comparisons of the means from intensity ratings by the wine industry evaluating 1984 musts and wine (Table 9) are difficult to interpret. For varietal character the must at 24 hours was significantly lower in intensity than both the must at 48 hours and the wine. There was no panelist-by-treatment interaction. Perhaps wine industry personnel are more comfortable evaluating must and wine aroma than they are evaluating juice aroma.

Overall aroma multiple comparison results were inconclusive. Musts at 24 and 48 hours were significantly different from each other, but neither was significantly different from the wine.

Figure 1. Percent Frequency of Term Usage as Shown on Pinot noir Juice Ballot.

NAME: ____________________
DATE: ____________________

PINOT NOIR JUICE BALLOT

DIRECTIONS: Please rate the sample AROMA on the following nine point intensity scale.

1--NONE
2--THRESHOLD
3--SLIGHT
4--SLIGHT TO MODERATE
5--MODERATE
6--MODERATE TO LARGE
7--LARGE
8--LARGE TO EXTREME
9--EXTREME

SAMPLE: __________

OVERALL AROMA	100%				
FRUITY	96%	BERRY	47%	RASPBERRY	19%
				BLACKBERRY	30%
				STRAWBERRY	15%
		TREE (FRUIT)	85%	CHERRY	51%
				PEAR	22%
				APPLE JUICE	61%
		DRIED FRUIT	78%	STRAWBERRY JAM	12%
				BLACKBERRY JAM	21%
				RASPBERRY JAM	11%
				RAISIN	25%
				PRUNE	42%
				FIG	29%
VEGETATIVE	89%	FRESH	78%		
		DRIED	31%		
EARTHY	27%				
CHEMICAL	29%				
SWEET	82%	CARAMELIZED	36%	HONEY	<36%

Figure 2. Percent Frequency of Term Usage as Shown on Pinot noir Wine Ballot.

NAME: ____________________
DATE: ____________________

PINOT NOIR WINE BALLOT

DIRECTIONS: Please rate the sample AROMA on the following nine point intensity scale.

1--NONE
2--THRESHOLD
3--SLIGHT
4--SLIGHT TO MODERATE
5--MODERATE
6--MODERATE TO LARGE
7--LARGE
8--LARGE TO EXTREME
9--EXTREME

SAMPLE: ________

ORDER OF EVALUATION: 1ST 2ND or 3RD (Please circle)

OVERALL AROMA	100%				
FRUITY	98%	CITRUS	45%	GRAPEFRUIT	39%
		BERRY	62%	RASPBERRY	33%
				BLACKBERRY	31%
				STRAWBERRY	16%
		TREE (FRUIT)	49%	CHERRY	30%
				PEAR	5%
				APPLE JUICE	15%
		DRIED FRUIT	71%	STRAWBERRY JAM	13%
				BLACKBERRY JAM	23%
				RASPBERRY JAM	8%
				RAISIN	32%
				PRUNE	13%
				FIG	27%
		LABRUSCA	17%		
FLORAL	83%	FLORAL	39%	LINALOOL	16%
SPICY	79%	SPICY	69%	BLACKPEPPER	56%
				CLOVES	28%
VEGETATIVE	71%	CANNED/COOKED	40%		
		FRESH	17%		
		DRIED	15%		
EARTHY	17%				
CHEMICAL	96%	PUNGENT	93%	ETHANOL	93%
		SULFUR	22%		
WOOD	32%	PHENOLIC	21%		
SWEET	76%	CARAMELIZED	36%	HONEY	14%
				DIACETYL	31%
				BUTTERSCOTCH	9%
				VANILLA	13%
MICROBIAL	48%	LACTIC	39%	SAUERKRAUT	26%

Table 1. Pooled Correlation Coefficients for the Purpose of Screening Panelists' Performance for Each Descriptive Term

Panelist	Overall	Fruity	Berry	Tree Fruit	Cherry	Apple Juice	Dried Fruit	Prune	Vegeta-tive	Fresh Vegetative	Sweet
1	−0.03	−0.15	0.15	0.21	0.19	0.29	0.25	0.50	−0.14	0.30	−0.20*
2	−0.17	−0.14	0.05	−0.19	−0.20*	−0.00	−0.40*	0.05	0.22	0.17	−0.11
3	0.31	0.19	0.43	0.11	−0.13	0.00	0.02	0.04	−0.02	0.09	0.20
4	0.37	−0.29*	0.42	0.02	0.10	−0.04	0.29	0.10	0.10	0.16	−0.24*
5	0.12	0.15	0.18	0.08	−0.02	−0.05	0.20	0.37	−0.02	0.08	0.12
6	−0.05	−0.36*	−0.08	−0.15	−0.05	−0.01	0.26	0.31	0.33	0.31	−0.40*
7	0.06	−0.16	0.14	0.18	0.22	−0.13	0.15	0.25	0.23	0.20	0.29
8	−0.18	0.16	0.10	0.18	——*	0.17	0.28	0.33	0.24	0.09	0.14
9	0.18	−0.13	−0.01	−0.05	0.14	0.12	−0.02	——*	0.56	0.51	−0.31
10	−0.02	−0.15	——*	−0.18	−0.14	−0.10	0.21	0.23	0.17	0.17	0.01
11	0.01	0.13	0.34	0.01	−0.27*	0.02	0.12	0.15	−0.04	0.08	−0.12
12	−0.22*	0.23	0.50	0.04	−0.12	−0.19	0.00	0.07	0.18	0.08	−0.11
13	0.28	−0.46*	−0.02	−0.25*	−0.14	0.10	−0.04	0.09	0.58	0.13	−0.03
14	−0.04	0.01	0.07	−0.05	−0.03	−0.32*	0.11	——*	0.63	0.61	−0.20*

—— = not estimable

* = pooled correlation coefficient less than −0.20 represents panelist eliminated from analysis.

Table 2. Means[ab] of Pinot noir Juice Aroma and Darkness Descriptor Intensity Ratings by Treatments and by Statistical Significance Levels of Control vs. Each Treatment

	Treatments				Significance Level of Contrast[c]		
	Control	Freeze	VR	D5L	Ctrl. vs. Freeze	Ctrl. vs. VR	Ctrl. vs. D5L
Aroma[a]:							
Overall	4.92	4.79	4.77	4.91	—	—	—
Fruity	4.32	4.05	4.26	4.28	—	—	—
Berry	2.12	2.06	2.15	2.07	—	—	—
Tree Fruit	3.00	3.11	3.19	2.97	—	—	—
Cherry	1.95	2.16	2.12	2.09	—	—	—
Apple Juice	2.38	2.38	2.49	2.23	—	—	—
Dried Fruit	2.89	2.56	2.76	2.88	—	—	—
Prune	2.12	1.90	2.06	2.22	—	—	—
Vegetative	3.39	3.65	3.03	3.08	0.01	—	0.05
Fresh Vegetative	2.88	3.08	2.58	2.60	—	—	—
Sweet	2.80	2.30	2.55	2.58	0.05	—	—
Appearance[b]:							
Darkness	0.91	0.63	1.56	1.56	0.01	0.01	0.01

a Nine point intensity scale (1 = none, 9 = extreme)

b Normalized magnitude estimates (reference = 100)

c Degrees of freedom were estimated by Satterthwaite approximation. All values here represent $p \leq 0.05$ or $p \leq 0.01$. No value indicates no significant difference.

Table 3. Mean Magnitude Estimates of "Darkness" of Experimental Juice and Wine

	Pinot noir Corvallis	Pinot noir Medford	Gamay beaujolais Corvallis	Average over Sources	Reference* for wine Evaluation
Juice					
Freeze	0.63^{ab}	0.60^{a}	0.65^{ab}	0.63^{f}	—
Control	0.90^{bc}	0.87^{abc}	0.96^{c}	0.91^{g}	—
VR	1.46^{d}	1.49^{d}	1.74^{d}	1.56^{h}	—
D5L	1.64^{d}	1.52^{d}	1.53^{d}	1.56^{h}	—
Reference*	1.04^{c}	1.07^{c}	0.67^{ab}	0.92^{g}	—
Average over Treatments	1.13^{e}	1.11^{e}	1.11^{e}	—	—
Wine					
Control	1.35^{j}	0.77^{i}	1.34^{j}	—	0.76^{i}

* Reference was Pinot noir-Corvallis, control juice.

NOTE: Same letter superscripts indicate no significant difference at $p \leq 0.05$ level.

abcd Marks the matrix (5x3) of juice samples.

e Marks the row of juice samples by treatment.

fgh Marks the column of average juice samples.

ij Marks the row of wine samples.

Table 4. Significance Levels from Correlation Analysis for Descriptor Intensity Ratings of Juice vs. Wine

Juice Descriptors	Treatments	WINE DESCRIPTORS Overall (1)	Fruity (1)	Citrus (2)	Berry (2)	Tree Fruit (2)	Dried Fruit (2)	Floral (1)	Spicy (1)	Spicy (2)	Black Pepper (3)	Vege-tative (1)	Canned/ Cooked (2)	Chemical (1)	Pungent (2)	Ethanol (3)	Sweet (1)	Micro-bial (1)	Dark-ness
Overall (1)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fruity (1)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Berry (2)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	*(-)	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tree Fruit (2)	Freeze	-	-	-	-	-	-	-	*(+)	-	*(+)	-	-	-	-	-	-	-	-
	Control	-	-	-	-	*(-)	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cherry (3)	Freeze	-	-	-	-	-	-	-	-	-	*(+)	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apple Juice (3)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	*(-)	-		-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dried Fruit (2)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(+)
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4. Significance Levels from Correlation Analysis for Descriptor Intensity Ratings of Juice vs. Wine (cont.)

Juice Descriptors	Treatments	WINE DESCRIPTORS Overall (1)	Fruity (1)	Citrus (2)	Berry (2)	Tree Fruit (2)	Dried Fruit (2)	Floral (1)	Spicy (1)	Spicy (2)	Black Pepper (3)	Vegetative (1)	Canned/ Cooked (2)	Chemical (1)	Pungent (2)	Ethanol (3)	Sweet (1)	Microbial (1)	Darkness
Prune (3)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	*(-)	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vegetative (1)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fresh Vegetative (2)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sweet (1)	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Darkness	Freeze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D5L	-	-	-	-	*(-)	-	-	-	-	-	-	-	-	-	-	-	-	-

NOTE: (1)(2)(3) denote tier on which term appeared on ballot.

*(+) $p \leq 0.05$, positive correlation

**(-) $p \leq 0.01$, negative correlation

Table 5. Degree Brix, Titratable Acidity and pH for Experimental Juices

		JUICE - TREATMENTS			
Measure-ment	Sources	Freeze	Control	VR	D5L
°Brix	Pinot noir Corvallis	21.1	21.1	21.0	21.0
	Pinot noir Medford	21.5	21.4	21.5	21.7
	Gamay Beaujolais Corvallis	20.8	21.2	21.2	21.2
Titratable* Acidity	Pinot noir Corvallis	0.85	0.90	0.92	0.88
	Pinot noir Medford	0.68	0.75	0.75	0.77
	Gamay Beaujolais Corvallis	0.97	0.99	0.99	0.97
pH	Pinot noir Corvallis	3.38	3.38	3.37	3.37
	Pinot noir Medford	3.33	3.35	3.36	3.35
	Gamay Beaujolais Corvallis	3.27	3.28	3.28	3.28

* g/100 ml tartaric acid

Table 6. Chemical Analysis^{+} of Twelve Experimental Pinot noir Juice Samples

		JUICE - TREATMENTS			
Chemical Analysis	Source	Freeze	Control	VR	D5L
Anthocyanin Pigment, mg/l	Pinot noir, Corvallis	11.24^{b}	6.45^{a}	15.51^{d}	17.23^{e}
	Pinot noir, Medford	21.01^{f}	27.88^{i}	25.31^{h}	25.20^{h}
	Gamay Beaujolais, Corvallis	13.11^{c}.	11.80^{b}	20.81^{f}	23.05^{g}
Color Density	Pinot noir, Corvallis	1.00^{c}	1.18^{e}	1.33^{g}	1.31^{f}
	Pinot noir, Medford	1.13^{d}	1.38^{h}	1.78^{k}	1.89^{l}
	Gamay Beaujolais, Corvallis	0.96^{a}	0.98^{b}	1.56^{j}	1.41^{i}
Polymeric Color	Pinot noir, Corvallis	0.48^{bc}	0.65^{ef}	0.62^{ef}	0.57^{de}
	Pinot noir, Medford	0.40^{a}	0.42^{ab}	0.67^{fg}	0.74^{g}
	Gamay Beaujolais, Corvallis	0.35^{a}	0.41^{ab}	0.61^{ef}	0.50^{cd}
Percent Polymeric Color	Pinot noir, Corvallis	48.21^{f}	54.74^{g}	47.12^{f}	43.28^{e}
	Pinot noir, Medford	35.36^{b}	30.34^{a}	37.82^{cd}	39.03^{d}
	Gamay Beaujolais, Corvallis	41.81^{e}	42.18^{e}	39.01^{d}	35.82^{bc}
Browning Index	Pinot noir, Corvallis	0.41^{d}	0.53^{gh}	0.49^{f}	0.46^{e}
	Pinot noir, Medford	0.33^{ab}	0.31^{a}	0.52^{g}	0.55^{h}
	Gamay Beaujolais, Corvallis	0.34^{bc}	0.35^{c}	0.49^{f}	0.41^{d}
Hunter "L"	Pinot noir, Corvallis	17.95^{cd}	22.10^{g}	19.45^{e}	22.55^{g}
	Pinot noir, Medford	18.50^{d}	11.85^{a}	19.55^{e}	21.20^{f}
	Gamay Beaujolais, Corvallis	16.85^{b}	17.80^{c}	28.65^{i}	26.25^{h}
Total Phenolic Content mg/l GAE*	Pinot noir, Corvallis	237^{abc}	391^{f}	274^{d}	265^{cd}
	Pinot noir, Medford	339^{e}	454^{g}	277^{d}	343^{e}
	Gamay Beaujolais, Corvallis	227^{a}	230^{ab}	346^{e}	257^{bcd}

\+ Means of measurements in duplicate

* GAE = Gallic acid equivalent
ANOVA applied to optical density readings but shown here as GAE based on standard curve.

abc... Same letter superscripts within each chemical analysis (three rows by four columns) indicate no significant difference at $p \leq 0.05$.

Table 7. Correlation Coefficients of Sensory Darkness vs. Chemical Analysis of Juice

Chemical Analysis	Correlation Coefficients	Statistical Significance Level
Anthocyanin Pigment	0.4105	--
Color Density	0.7402	0.01
Polymeric Color	0.6999	0.05
Percent Polymeric Color	-0.1171	--
Browning Index	0.6635	0.05
Hunter "L"	0.6849	0.05
Total Phenolic Content	-0.0340	--

Table 8. Means from Intensity Ratings* by Members of the Wine Industry Evaluating 1983 Pinot noir Juice Treatments and Wine

	Treatments	Varietal Character+	Overall Aroma	Color Intensity
Juice -	freeze	4.04	5.04[a]	4.18[a]
	control	4.20	5.36[a]	5.86[b]
	VR	4.39	5.57[a]	7.66[c]
	D5L	3.98	4.93[a]	7.50[c]
Wine -	control	7.00	6.89[b]	3.79[a]

* Nine point intensity scale (1 = low, 9 = high).

abc Same letter superscripts in the same column indicate no significant difference at $p \leq 0.05$.

\+ The panelist treatment effect was significant for varietal character. Therefore, multiple comparisons were not completed.

Table 9. Means from Intensity Ratings* by Members of the Wine Industry Evaluating 1984 Pinot noir Musts and Wine

	Varietal Character	Overall Aroma
Must - 24 hours	3.63[a]	4.50[a]
Must - 48 hours	5.56[b]	5.83[b]
Wine - 7 months	5.06[b]	5.00[ab]

* Nine point intensity scale (1 = low, 9 = high).

ab Same letter superscripts in the same column indicate no significant difference at $p \leq 0.05$.

V. SUMMARY AND CONCLUSIONS

Descriptive terminology differed between Pinot noir juice and Pinot noir wine. Some terms were the same for both juice and wine, some were dropped from wine description, and some were added. Some of the terms used were not useful for the Pinot noir juices and wines evaluated.

The treatments created subtle, if any, aroma differences. Differences were evident in color, as measured by human perception and by instrumental analysis. The enzyme treatments increased color extraction from the grape skins. Freezing and thawing of the crushed grapes prior to pressing decreased color extraction.

Some characteristics of wine aroma correlated with juice aroma. However, because only seven out of a possible 748 correlations were different from zero, there is no good evidence to suggest that any strong relationships exist between juice and wine aroma description for these experimental samples.

Only two out of 112 correlations between perceived color (darkness) and aroma were found to be statistically significant. Therefore, there is no good evidence to suggest that relationships between darkness and aroma exist for these experimental samples.

Perceived color correlated with some of the analytical color measurements. The strongest correlation was found between perceived darkness and Somer's color density measurement (the sum of the corrected absorbances at 420 and 520 nm.).

Very little was learned from the industry panel. There seemed to be lack of agreement on the definition of Pinot noir varietal character. More work is needed to develop the terminology to define this frequently used term.

Prediction of wine quality from juice quality may be easier for some other wine grape varieties (especially the muscat family). The lack of significant correlations between juice and wine aroma descriptors in this study make it unclear whether the potential is there for Pinot noir. Future approaches, will need to be different. Research should be less concerned with enzyme or freeze treatments, and more concerned with obtaining greater variation in juice characteristics, increasing the number of sources studied, and evaluating those sources over time. Also, greater emphasis should be placed on evaluating the descriptive terminology using statistical techniques, such as principal component analysis (PCA).

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VII APPENDICES

Standards used for Pinot noir juice and wine aroma description

Term	Standard
raspberry	frozen raspberry, Flavorland
blackberry	frozen Marionberries, Flavorland
strawberry	frozen strawberries, Flavorland
cherry	Royal Ann, Diamond A - heavy syrup Dark Sweet, Diamond A - heavy syrup
pear	canned pear, canned in natural juice, My-te-fine
apple juice	apple juice, Tree Top, single strength
strawberry jam	strawberry jam, Smuckers
blackberry jam	blackberry jam, Smuckers
raspberry jam	raspberry jam, Smuckers
raisin	raisin, My-te-fine
prune	prunes, Del Monte, in Sunsweet prune juice
fig	dried figs, Mission
fresh vegetative	fresh Emperor grapes, crushed
dried vegetative	wet straw
caramelized	caramelized sugar
honey	clover honey, Sue Bee
grapefruit	fresh grapefruit peel
labrusca	grape juice, Welches
linalool	linalool in glass wool
black pepper	black pepper
cloves	whole cloves
ethanol	10% m water
butterscotch	candies
vanilla	vanilla extract
sauerkraut	sauerkraut, Steinfeld's, in glass

NAME: ____________________
DATE: ____________________

PINOT NOIR JUICE BALLOT

DIRECTIONS: Please rate the sample AROMA on the following nine point intensity scale.

1--NONE
2--THRESHOLD
3--SLIGHT
4--SLIGHT TO MODERATE
5--MODERATE
6--MODERATE TO LARGE
7--LARGE
8--LARGE TO EXTREME
9--EXTREME

SAMPLE: ________

OVERALL AROMA	______				
FRUITY	______	BERRY	______	RASPBERRY	______
				BLACKBERRY	______
				STRAWBERRY	______
		TREE (FRUIT)	______	CHERRY	______
				PEAR	______
				APPLE JUICE	______
		DRIED FRUIT	______	STRAWBERRY JAM	______
				BLACKBERRY JAM	______
				RASPBERRY JAM	______
				RAISIN	______
				PRUNE	______
				FIG	______
VEGETATIVE	______	FRESH	______		
		DRIED	______		
EARTHY	______				
CHEMICAL	______				
SWEET	______	CARAMELIZED	______	HONEY	______

NAME: ____________________
DATE: ____________________

PINOT NOIR WINE BALLOT

DIRECTIONS: Please rate the sample AROMA on the following nine point intensity scale.

1--NONE
2--THRESHOLD
3--SLIGHT
4--SLIGHT TO MODERATE
5--MODERATE
6--MODERATE TO LARGE
7--LARGE
8--LARGE TO EXTREME
9--EXTREME

SAMPLE: __________

ORDER OF EVALUATION: 1ST 2ND or 3RD (Please circle)

OVERALL AROMA	______				
FRUITY	______	CITRUS	______	GRAPEFRUIT	______
		BERRY	______	RASPBERRY	______
				BLACKBERRY	______
				STRAWBERRY	______
		TREE (FRUIT)	______	CHERRY	______
				PEAR	______
				APPLE JUICE	______
		DRIED FRUIT	______	STRAWBERRY JAM	______
				BLACKBERRY JAM	______
				RASPBERRY JAM	______
				RAISIN	______
				PRUNE	______
				FIG	______
		LABRUSCA	______		
FLORAL	______	FLORAL	______	LINALOOL	______
SPICY	______	SPICY	______	BLACKPEPPER	______
				CLOVES	______
VEGETATIVE	______	CANNED/COOKED	______		
		FRESH	______		
		DRIED	______		
EARTHY	______				
CHEMICAL	______	PUNGENT	______	ETHANOL	______
		SULFUR	______		
WOOD	______	PHENOLIC	______		
SWEET	______	CARAMELIZED	______	HONEY	______
				DIACETYL	______
				BUTTERSCOTCH	______
				VANILLA	______

NAME: ____________________
DATE: ____________________

PINOT NOIR JUICE BALLOT

DIRECTIONS: Assign the reference sample a value of 50. Rate the other samples in relation to the reference for the parameter. For example, if it is three times as strong, assign it 150. If it is half as strong, assign it 25.

DARKNESS:

This is a measure of how much light can pass through the sample. A high value reflects a sample with a high degree of darkness or opacity where minimal light passes through. A low value reflects a sample where more light passes through.

CODE	VALUE
ref	50

NAME: ____________________
DATE: ____________________

PINOT NOIR WINE BALLOT

DIRECTIONS: Assign the reference sample a value of 50. Rate the other samples in relation to the reference for the parameter. For example, if it is three times as strong, assign it 150. If it is half as strong, assign it 25.

DARKNESS:

This is a measure of how much light can pass through the sample. A high value reflects a sample with a high degree of darkness or opacity where minimal light passes through. A low value reflects a sample where more light passes through.

CODE	VALUE
ref	50

NAME: ____________________

PINOT NOIR JUICE/WINE EVALUATION
OSU - Sensory Science Lab

Directions:

You are to evaluate one Pinot noir wine and four samples of Pinot noir juice by rating intensity of overall aroma, varietal character, and intensity of color on a scale of one to nine (where one is low intensity and nine is high intensity.

DO NOT TASTE. Overall aroma and varietal character will be evaluated by sniffing only. Intensity of color will be evaluated by looking at samples in a lighted booth.

Please place the sample number in the appropriate box below to describe your impression of intensity for each of the following qualities.

It is important that you understand these directions. If you have questions, please ask.

Intensity Rating	Overall Aroma	Varietal Character	Intensity of Color
9 - high intensity			
8			
7			
6			
5 - moderate intensity			
4			
3			
2			
1 - low intensity			

Any comments?

NAME: ____________________

PINOT NOIR MUST EVALUATION
OSU - Sensory Science Lab

Directions:

You are to evaluate samples of Pinot noir taken at intervals during fermentation by rating intensity of overall aroma and varietal character on a scale of one ot nine (where one is low intensity and nine is high intensity).

DO NOT TASTE THE SAMPLES. Evaluate by sniffing only.

Place the sample number in the appropriate box below to describe your impression of intensity for each of the following qualities.

If you have questions, please ask.

Intensity Rating	Overall Aroma	Varietal Character
9 - high intensity		
8		
7		
6		
5 - moderate intensity		
4		
3		
2		
1 - low intensity		

Any comments?