



Red light masks the color in a sensory evaluation of wine by A. C. Noble. Opaque glasses are also used to eliminate influence of color on wine tasters.

Over the past 100 years the art of sensory evaluation of wines has been advanced to a science, in large part through research performed at the University of California. Initially, sensory evaluation was a necessary but informal and perfunctory part of assessing wine quality. However, even as an unrefined observational tool, it contributed to early grape and wine research.

In 1935 Professor William Cruess proposed three separate 100-point scorecards for rating white and red table wines and dessert wines. Later, basic guidelines also were suggested whereby wines were to be judged for freedom from defects and "trueness to type." With the original scorecards as a starting point, M.A. Amerine and A.J. Winkler developed a 100-point scorecard to provide more objective evaluations of wine by "freeing the tasters of preconceived ideals." Points were assigned on: appearance 10, color 10, odors 15, volatile acidity 10, total acidity 10, dryness 8, body 6, taste 15, smoothness and astringency 10, and general quality 8. From 1935 to 1959 the 100-point scorecard was used in evaluating wine grape varieties in the five climatic regions of California. From these accumulated data, extensive recommendations were made to the wine industry for the most suitable grape varieties to plant in specific regions.

Recognizing that, of the 100 points on the scorecard, the range from 70 to 79 was used almost exclusively, the Davis 20-point scorecard was then proposed with the following point distribution: appearance 2, color 2, aroma and bouquet 4, volatile acidity 2, total acidity 2, sugar 1, body 1, flavor 2, astringency 2, and general quality 2. Since its introduction, the 20-point card has been used for most overall wine evaluations in subsequent varietal trials and in most of the viticultural and enological studies performed at the University. Although the 20-point scorecard was later shown to have an effective range of only 5 to 7 points, it has been consistently used.

In 1952 U.C. researchers were the first to examine tasting results by analysis of variance. This statistical technique, now widely used, removes subjectivity from sensory evaluation by establishing judge reliability and consistency, as well as by testing the significance of the results.

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## Wine tasting is a science

A.C. Noble

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In the early 1960s the importance of scoring wines by region and by type was demonstrated. Since a judge's concept of quality is affected by the combination of wines tested at one sitting, testing wine of one type provides more consistent results.

In a recent examination of the 20-point system, University researchers found that trained tasters required up to five years to consistently use the 20-point system, whereas scoring wines on a 9-point scale required less training. Although use of an overall rating scale will always be subject to slightly different use by different individuals and to the inevitable effect of one component (such as a dark color) on other components (such as oxidized aroma), use of the 20-point card with recorded comments has provided valuable information over the years.

Most recently, U.C. researchers have been using "profile" or "descriptive" scoring tests. Here, rather than assigning an overall quality rating to a wine, they rated the intensity of individual aroma attributes such as vegetative, woody, or fruity to characterize a series of commercial Cabernet Sauvignon wines. Similarly, in evaluating the effect of cropping level on Zinfandel wines, terms such as overall aroma or taste intensity were rated. In a study of the effect of oxidation by exposure to air, specific changes in wine flavor were measured by rating the intensity of fruity and oxidized flavors. This technique promises to provide very effective evaluation of wine treatments in the future.

In addition to developing systems for scoring wine, University researchers have contributed to an understanding and application of the basic principles of sensory evaluation. As early as 1939, recognizing the bias created by prior knowledge of a wine's identity, they advocated the use of coding or "blind" tasting procedures. In 1952, the basic principles of sensory evaluation needed to provide valid results were summarized. Observing the effect of distractions on panel performance, researchers recommended that wine scoring be performed in a quiet, odor-free, and isolated location. The effect of order of presentation in influencing the results similarly resulted in advice to present samples in a random but different order to each judge.

Since the 1950s, contributions from Davis researchers have helped to bring the food and wine industries and fairs from haphazard to controlled tastings. In a review of sensory practices

in the industries, however, it was found that only one of the 50 wineries surveyed used statistical analysis in interpreting experimental results, and only eight had a special room for sensory testing.

Application of difference tests, such as the pair and triangle tests, was introduced in 1948. These tests have been used to show whether winery or field treatments, such as mechanical harvesting of grapes, have a significant effect on wine sensory properties.

Basic information on many topics, such as sourness, has been accumulated as well. Threshold levels (the minimum detectable amount of a substance) were determined for acids and other components in water and wine. Investigating the sourness of different acids and concentrations of acids, researchers concluded that sourness is best correlated with the log of titratable acidity. In studies of the interrelationship of sourness, sweetness, and bitterness in wine, it was found that increasing concentrations of either acid or caffeine depressed sweetness, but that adding sugar had no effect on detection of acid. Interestingly, in a study of salivary response to tasting of wine and its separate components, salivary flow rates were higher in response to aqueous tartaric acid solutions than to wines containing the same acid concentration. Addition of ethanol to the aqueous acid solution reduced the flow rate of saliva, which was consistent with a previous observation that addition of ethanol to acid systems results in decreased sourness. With the recent information on the relationship of organic acid anions, pH, and titratable acidity, our on-going research promises to contribute further to our understanding of the theory of sourness.

Much of the research done at the University has facilitated the use of sensory evaluation by trained tasters as an analytical, objective, and reliable method of analysis. However, because of the time and expense involved in sensory testing, attempts are continually being made to develop procedures to replace the sensory test with chemical or instrumental analyses.

In 1953, U.C. researchers sought to predict overall wine scores for Cabernet Sauvignon wines using alcohol, total acid, hydrogen ion concentration, tannin, and volatile acid. When any one of the indicators was used, predictability was low, but as is statistically inevitable, using all five parameters increased the ability to predict the wine scores. In a series of experiments studying the effect of cropping level on Zinfandel aroma, various wine analyses and gas chromatographic peaks (collected from wine aroma) were correlated with both cropping level and sensory rating scores. Several peaks and various must or wine data correlated linearly with crop levels. Gas chromatographic peaks were correlated with the intensity of specific attributes (vegetative, fruity, woody, and the like) rated in a series of Cabernet Sauvignon wines. Because of the nature of the statistical tests used and the variability of the systems studied, further research is necessary before conclusions can be reached about the importance of specific components to wine flavor.

Recently, with the technique of principal component analysis, we were able to "cluster" wines by variety using data from gas chromatography of wine aroma components. Although no formal sensory testing was involved, perhaps the most successful correlation of sensory and instrumental analysis has been the identification of the component producing an intense geranium odor in wine. Researchers isolated 2-ethoxyhexa-3,5-diene and outlined the mechanism for its formation from sorbic acid in wines undergoing malo-lactic fermentation.

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## Wine — a multibillion-dollar industry

Kirby S. Moulton

**T**he current problems of the California wine industry all have parallels in the industry's earlier days. Its history is a fabric of high and low profits, overplanting and underplanting, surplus and shortage, and ascending and descending preferences. The industry has become robust and exceedingly complex but has never really resolved the problem of the profitable coordination of grape production and wine sales.

Nearly every observer of the California wine scene is aware of the great grape planting spree of the 1970s when "...nearly every land owner caught the wine fever...and vineyards sprang up as if by magic all over California." But those words were written in 1878 by Charles Kohler in his University of California master's thesis about planting excesses which happened in the 1850s.

### The evolving structure

California's vineyards expanded enormously between 1880 and 1980, and much of this growth occurred relatively early. The 56,000 acres reported in 1880 doubled by 1885 and reached almost 350,000 acres 25 years later. The initial expansion was almost entirely in grapes for winemaking, which represented three-quarters of the 1885 acreage.

The increase placed great stress on wine marketing just as it has more recently. Grower prices tumbled from over \$20 per ton in the early 1880s to less than \$10 per ton by the end of the decade. Imports posed serious market threats, and dishonest selling practices diminished grower and winery profits.

Some marketing problems were described by Professor E. W. Hilgard in 1880. They included the practice of selling California wines under foreign labels "after two trips across the Atlantic, or even perhaps only across the bay." Blending was left chiefly to the wine merchants of San Francisco with somewhat uncertain quality results. Professor Hilgard noted, however, that neutral spirits, log-wood, glycerine, and sulphuric acid played relatively small roles in blending practices of these merchants. The Mission variety grape common in California's early vineyards was believed by Hilgard and others to contribute to marketing problems: the low-quality wines made from Mission encouraged the production of sweet wines to mask the grape's defects.

Reduced yields were necessary to produce quality wines, but quality-based price differentials rarely compensated for the loss of sellable grape tonnage. The dilemma was painfully evident in the severe depression of the 1870s. The choice for growers was to plant other crops or turn the hogs into the vineyards at harvest time. Wineries fared little better. Economic disasters squeezed their number from 139 in 1870 to only 45 registered in California in 1880.

Wine drinkers in the United States consumed about 28 million gallons of wine annually during the 1880s, a level stimulated by improved marketing and augmented production. Even with increased demand, U.S. producers successfully thwarted foreign competition, and imports were cut in half between the 1870s and 1880s to less than 20 percent of the expanding market. Nevertheless, the volume of imports was always significant in the pre-Prohibition U.S. wine market, and dropped to an unimportant 3 percent