

Sensory Evaluation of Wine and Commercial Realities: Review of Current Practices and Perspectives

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Abstract: The attributes of a wine rely on the sensory acuity of the winemaker or the winemaker's team. Depending on the winery operations or the style of wine made, the winemaker can be viewed as the expert crafting an artisan wine or producing a commercial alcoholic beverage designed to appeal to many consumers. The globalization of the wine market now enables more consumers to taste wines produced in foreign regions. Winemakers producing popular wines have been challenged by evolving consumer needs, values, and motivations for drinking wines, consumption habits, and greater product competition. This review discusses the tools sensory evaluation provides to assist winery operations by characterizing wine sensory properties and by better understanding consumer preferences in order to design better wine styles. By reviewing the scientific and marketing literature, key concepts are illustrated and new perspectives for consumer-driven winemaking and wine business strategies are proposed.

Key words: sensory evaluation, wine, expertise, winery operations

Tasting wine has always been a part of the standard operations of a winery. Although this function was traditionally assigned to one or several winemakers, the use of sensory evaluation techniques has increased since the late 1980s, especially under the leadership of Ann Noble at the University of California, Davis, who has taught good sensory practices to evaluate wine. In 2000, a sensory symposium was organized as part of the 50th anniversary meeting of the American Society of Enology and Viticulture. In Noble's introduction, she noted that wineries were not "taking advantage of the vast strides that have been made in sensory methods and data analysis" (Noble 2001). Case studies were presented that illustrated the benefits for medium- and large-size wineries to use good sensory practices and sensory methods in their research, development, and marketing programs (Chacon-Rodriguez et al. 2001, Lesschaeve 2001, de la Presa Owens 2001). A key realization of this sensory symposium was that although the wine industry valued sensory data, very few wineries were actually using sensory techniques in their winery operations, except in research and develop-

ment projects and often in collaboration with academic partners. This review article examines recent contributions of sensory science in the fields of enology and viticulture; discusses wine-tasting expertise in the context of commercial realities; describes sensory techniques successfully used in commercial research, development and marketing research; and offers perspectives for the future.

Wine Expertise and Commercial Realities

The evaluation of wine quality has traditionally been in the hands of winemakers, who have the training and experience to detect faulty wines and to craft wine according to a specific style. Peynaud (1996) claimed that "the role of tasting expertise is not the identification of anonymous wines, but the exercise of quality control. Its function is to judge whether a wine is free of fault, which might lessen its value or render it unfit for consumption and to see whether it has the qualities required by its denomination." In medium- to large-scale operations, winemaker expertise is used to develop new wine styles based on marketing information and recommendations. Experienced winemakers, wine judges, and wine writers are considered wine experts by the public and by their peers. Moreover, the public views wine experts as people who can help them choose the right wine for the perfect occasion. Thomas and Pickering (2003) surveyed New Zealand wine consumers on the importance of information displayed on wine bottle labels. They found that when consumers examined wine labels to determine their purchase decisions, they first look for winery, then for brand name, and then for opinions of wine experts and awards and medals.

But what is a wine expert? An expert is defined by American Society of Testing Materials as someone (often operating alone) with extensive experience in a product category who performs perceptual evaluations to draw conclusions about the effects of variations in raw materi-

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The author is with Inno Vinum, which, together with Compusense, has developed and distributes Wine Descriptive Analysis. Compusense also markets the FCM, discussed in this review article.

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als, processing, storage, aging, and so on (ASTM 2005). The sensory evaluation committee of ASTM distinguishes an expert from an expert assessor, who is someone with a “high degree of sensory acuity who has experience in the test procedure and established ability to make consistent and repeatable sensory assessments. An expert assessor functions as a member of a sensory panel.” In the wine world, an expert is rarely an expert assessor, since replicate assessments are not current practices in the wineries or in the trade (Peynaud 1996). However, it is expected that an expert would have a superior sensory acuity.

In recent years, experimental psychology paradigms have been used to explore whether wine expertise was mainly cognitive or whether superior perceptual ability was also a characteristic. In one study, results indicated that wine experts have superior odor recognition memory than novices (Parr et al. 2004). In another study, wine experts were able to use more accurate descriptions than novices, which facilitated their ability to match the appropriate description with the corresponding wine (Valentin et al. 2003). These results suggest that wine experts have superior ability than novices to discriminate between, recognize, and describe different wines (Hughson and Boakes 2002). It is interesting to examine how this expertise relates to the consumer sensory experience. In a study of consumer response to the information contained on wine bottle back labels, the key finding was that consumers had difficulty matching label sensory descriptions with corresponding wines, although the majority of respondents claimed they read back labels as a purchase decision tool (Charters et al. 2000). This finding is in concordance with work that showed discrepancies between expert and consumer vocabulary (Solomon 1990, Lesschaeve 2003a).

Can wine experts make repeatable sensory assessments, assuming they would perform sensory tests according to established standardized procedures? The literature is scarce on the repeatability of wine expert ratings. Trade publications do not report these data. Data from this author suggest that wine experts are likely to provide repeatable evaluations; however, their quality assessments are rarely aligned with other wine expert ratings (Lesschaeve, unpublished data). Wine experts tend to be more repeatable than novices in the vocabulary they use to describe wine, likely because of a superior olfactory memory performance (Parr et al. 2004).

However, the superior abilities of wine experts seem to be linked to their greater wine knowledge rather than to superior sensory acuities (Parr et al. 2004, Hughson et al. 2002, Gawel 1997, Lawless 1984). Wine experts would rely on prototypic description of wine (“I smell gooseberry therefore it is a Sauvignon blanc and I *should* also smell grapefruit and cat urine”) instead of relying on their sensory perceptions at the time of the tasting.

Whereas wine expertise is critical in winery operations to ensure production of nonfaulty wines, there is no apparent evidence that wine expertise can predict consumer

liking scores or market success. This absence of correlation between consumer blind liking scores for five Merlot wines and their respective scores on a 100-point scale has been reported (Lesschaeve 2003b) (Table 1). Although naive consumers and experts tend to perceive similarly the sensory differences between products as shown in coffee (ESN 1996) and sauce products (Moskowitz 1996), liking scores can be dramatically different (Lesschaeve 2003b). Moreover, among wine consumers, segmentation based on sensory preference exists and leads to a different approach of wine style design and wine marketing (Yegge and Noble 2001, Lesschaeve et al. 2002, Lesschaeve and Findlay 2004). The use of sensory evaluation therefore brings complementary tools and information to traditional wine tasting conducted by wine experts.

Analytical Sensory Tools to Characterize Wine

Sensory evaluation is a scientific discipline used to evoke, measure, analyze, and interpret reactions to stimuli perceived through the senses (ASTM 2005). Sensory tests are conducted according to protocols minimizing physiological and psychological biases that could affect the sensory response of the sensory panelists (Lawless and Heymann 1998). Sensory professionals consider sensory panels as equivalent to high-tech analytical instruments, and therefore expect sensory data collected from panels to be accurate, sensitive, repeatable, and reproducible. Panel members are therefore selected based on their sensory acuity and are trained to perform sensory tasks objectively and consistently (Issanchou et al. 1997). Sensory specialists are encouraged to track panel performance on a regular basis to monitor any shift in the sensory acuity or ability of panelists. Several visual and statistical tools have been published to assist sensory professionals in evaluating panel and panelist performance (Schlich 1994, Hirst and Naes 1994, Naes and Solheim 1991, Rossi 2001).

For wine, sensory techniques have been mainly used to support research efforts in viticulture and enology, with a major objective of characterizing the sensory impacts of

Table 1 Consumer liking scores and expert quality ratings for five Merlots from Washington State (Lesschaeve 2003b).

Vintage	Location	Quality rating ^a	Liking score ^b mean (SD)
1999	Columbia Valley	91	46.5 (17.1)
1999	Columbia Valley	91	59.6 (23.2)
1999	Tri cities	88	53.7 (22.5)
1999	Columbia Valley	84	44.9 (25.9)
2000	Walla Walla Valley	89	64.2 (21.5)

^aExpert quality rating published in 2002 by the Wine Spectator on a 100-point scale.

^bRated by 41 Canadian red wine consumers on a 100-point scale: 0 = I do not like it at all; 100 = I like it very much. Wines were presented blind. Note the wide dispersion of scores.

viticultural or enological treatments on finished wine (Francis et al. 1992, Heymann and Noble 1987, Cliff and Dever 1996, Reynolds et al. 1996). Sound sensory methods have also been used to address industry issues such as cork taint and effectiveness of alternative closures. Protocols have been proposed to check the absence of off-notes in cork batches using quality-control methodologies based on statistical sampling and sensory panel data (Butzke and Suprenaut 1998, Lagace and Lesschaeve 2001). The effect of alternative closures has been studied and the results used to select closures that best preserve desirable sensory attributes in wine (Francis et al. 2003). The use of sensory techniques in research is well adopted in academia. In contrast, industry professionals rely on internal or external wine experts. Implementing a sensory program is perceived as an expensive investment. The complementary roles of sensory information and on-site wine expertise are often not understood by winery owners. A major concern of wineries might be that, instead of pur-

chasing a piece of equipment to run a chemical analysis of wines, they have to hire human resources. Such an expense does not affect the same budget line, and it entails hiring a sensory specialist who can manage a panel and implement an appropriate sensory program. Experimental data collected with limited resources in a commercial winery indicated that the implementation of a sensory program using winery personnel and sound sensory techniques could be cost effective (Chacon-Rodriguez et al. 2001). The success of such an internal program is linked to the effective support of winery management (Noble 2001). The Feedback Calibration Method (FCM: Compulse, Guelph, ON) was recently developed to reduce the training time of descriptive panelists (Findlay et al. 2006). In one instance, a newly trained FCM panel performed similarly to an experienced wine panel in half the time.

The key components required for a commercial sensory program with low cost and optimum conditions are summarized in Table 2. Good sensory practices can be imple-

Table 2 Key components in implementing a sensory program in commercial wine operations.

Component	Generic requirements ^a	Cost-effective implementation for occasional sensory activities	Optimum implementation for regular sensory activities
Tasting room	Quiet environment: free from noise, odor, visual disturbances Individual tasting booth	Conference room away from production plant Individual tables to minimize panelist interactions or temporary booth with odor-free cardboard dividers	Dedicated sensory lab with preparation lab Permanent booth with dividers and light-control features
Data collection	Questionnaire featuring test instruction and scorecard to record individual assessments	Paper questionnaire	Computerized questionnaire from sensory software
Panel	<i>Recruitment^b</i>	<i>Internal panel</i>	<i>Preferably an external panel</i>
	Screening	Screening of volunteers on basic tastes and wine faults and wine typical aroma recognition; availability and motivation ^c	Two- to three-step screening of volunteers recruited outside winery; screening based on sensory acuity, odor description ability, olfactory memory, motivation, interests, and long-term availability (Issanchou et al. 1995)
	Training	Short training session on methodology ^c	Comprehensive training (Meilgaard et al. 1987) or a basic training
	Control of panel performance	Occasional on some duplicated sample assessment	On-going with reference identification, duplicate sample assessments
Methods	Sensory tests	Difference, ranking, sorting tasks, descriptive analysis on limited predefined descriptors	Difference, ranking, sorting tasks, descriptive analysis of full sensory profile
	Analysis of sensory data	Acquire inexpensive statistical package to perform univariate (ANOVA) and multivariate (PCA) analyses	Acquire packages to run predictive modeling, outsource sophisticated analysis, or hire a statistician
Sensory personnel^b	(1) Laboratory technician to prepare samples; (2) sensory specialist to plan, conduct, analyze sensory tests	Same person often assumes both roles; hire students with at least 2 courses in sensory evaluation to conduct short-term projects or to implement the program and write standard procedures	Hire consultant to implement a program and train on-site staff or hire a university degreed sensory specialist (food science or enology and viticulture) and a college degreed laboratory technician

^aDetailed information found in Lawless and Heymann 1998, Meilgaard et al. 1987.

^bDetailed information found in Issanchou and Lesschaeve 1993.

^cDetailed information found in Chacon-Rodriguez et al. 2001.

mented in winery operations by small adjustments in current practices in departments other than research and development, including quality control, inventory and brand management, blending, competitive testing, and new market development. Tasting should be organized by a third party in an appropriate tasting room, wines should be served blind, tasters should not be informed of the purpose of the test, and individual tasting data and comments should be collected independently before any group discussion. Decisions emerging from the tasting should be based on the data and not on the opinion of the group leader, regardless of experience. Tasters should be invited to maintain their tasting skills through regular training periods. Managing such programs requires a dedicated position and must be fully endorsed by winery managers and employees.

Sensory analysis may not be used as widely as it should because wine professionals think of it as a research tool rather than as a business tool. Sensory professionals might not be proficient at communicating that sensory data as actionable data. However, wineries have increasingly been interested in the potential of combining sensory evaluation and market research to enhance their understanding and targeting of consumer wine preferences.

Combining Sensory and Marketing to Design New Wine Styles

Wine companies have recognized the need to better understand consumer preferences to sustain and develop their businesses in a global competitive market. Such an understanding allows wineries to design wine styles that better respond to consumer needs, wants, and expectations.

Market researchers traditionally survey volume sales to track market trends for a given product and they also characterize demographics, such as age, gender, and lifestyle, of both purchasers and nonpurchasers. Such data can reveal product winners and losers in terms of market share. To understand why the sales of some products decline, market researchers usually conduct qualitative tests, such as focus groups, with consumers who purchase the products in a particular category (Kanetkar 2000). During a typical 90-minute session, consumers discuss with a moderator why they do or do not like or purchase a product. Product tasting (blind or labeled) can be organized to elicit consumer opinion. The information retrieved is qualitative and provides direction on whether the lack of preference is due to sensory profile, packaging, or supply chain. However, this qualitative information is limited in its utility, and it is risky to make business decisions based on intuition and observation of consumer views in a focus group (Lawless and Heymann 1998). One study highlighted discrepancies among consumers, wine connoisseurs, and sensory descriptive panelists concerning sensory perceptions labeled under the same sensory attribute (Lesschaeve 2006). For example, the sensory at-

tribute “oak barrel” used by the sensory panel was not correlated with the “woody” attribute used by the consumers, which was correlated with “vanilla” when consumers liked the wines or with “smoky oak” when they did not.

Quantitative data collected with appropriate consumers or sensory panels are therefore critical to guide effectively product development or winemaking processes. Market researchers usually organize hedonic tests in different cities, thus representing the range of consumers intended for study. During these central location tests, consumers taste the products, side by side or one by one, and indicate their liking either on a hedonic scale or by ranking products according to their preference. Diagnostic questions usually follow to determine if the level of certain characteristics, such as sweetness, acidity, and fruitiness, is “just about right,” “too weak,” or “too strong.” If necessary, these diagnostic questions are used by technical staff to modify the wine sensory profile. Technical staff chose the diagnostic questions based on preliminary tasting and the differences they expect consumers will perceive. Product developers/winemakers must be aware that the consumer response is reflective of consumer interpretation of sweetness and not the product developer’s or the winemaker’s interpretation of sweetness. This latter assumption is the major issue with this technique, as it has been demonstrated many times that consumer language is different from technical language (Lawless 1984, Hughson and Boakes 2002, Lesschaeve 2006). Researchers, product developers, winemakers, and managers often assume they know what consumers expect, what consumers mean, and what magnitude of difference consumers can detect between two products. These assumptions are made based on the data they have collected through qualitative tests or through feedback from sales staff or other gatekeepers, such as distributors and wine writers. Therefore, product development is driven by what they think is “good” for consumers. While this approach can be successful, there is a high percentage (90%) of new food and beverage products that fail in the marketplace (Watzke and Saguy 2001).

New approaches for product development have received increasing attention in the food industry and are truly consumer driven (Saguy and Moskowitz 1999), from concept ideation through product optimization to market testing. These techniques use quantitative methods based on principles of psychophysics; the basis of this technology is that consumers cannot verbalize adequately why they like or do not like a product; however, they can react to sensory stimuli, such as color, flavor, texture, and appearance. Techniques have been developed to facilitate an understanding of consumer hedonic responses in terms of objective measurements. These techniques avoid the need to interpret consumer language. In practice, products are analyzed for chemical, flavor, and sensory profiles using analytical techniques, including sensory analysis, in addition to consumer hedonic responses. By correlating

these sets of objective measurements with consumer liking scores, the objective parameters (alone or in combination) that drive consumer likes and/or dislikes can be identified; furthermore, the optimal product formulation for a particular consumer segment can be determined. Preference mapping is one of these techniques (Greenhoff and MacFie 1994) that can be used to explore relationships between competitive products in a given category and to group consumers who have similar liking patterns. This technique has been used to study consumer preferences and to identify opportunities where no products exist. The development of a new product based on preference map data is known as “reverse engineering” (Moskowitz 1994). Once a developer has identified an area on a preference map to position a new product maximizing consumer liking scores, it is a straightforward process to determine the optimal sensory profile of the new product by modeling each sensory attribute by a quadratic function of the liking score. This approach has been used for new wine style development (Lesschaeve and Findlay 2004) and other products (Moskowitz 1994). Other modeling techniques used in the food industry include partial least squares (Martens and Martens 1986) PrefMap (McEwan 1996), and PrefMaX (Schlich et al. 2003).

While preference mapping and reverse engineering allow researchers to identify and target sensory preferences of wine consumers, the success of a new product on the market depends upon combining both the sensory and marketing attributes of the product. Finalizing only the sensory profiles does not guarantee market success. For example, few differences were shown between consumer liking scores for 10 inexpensive Chardonnay wines in blind and informed (showing bottle label) conditions with American consumers (Yegge and Noble 2001); however, significant differences were shown for Champagne wines (Lange et al. 2002) and Burgundy wines (Lange 2000), where external information had more weight than wine sensory properties on French consumer liking scores. These discrepancies in outcomes might be due to wine category studies, price range, reputation of wineries or brands, or cross-cultural differences between the two groups of consumers. Price point was also found as a constraint that moderates purchase intent and actual purchase behavior (Lange et al. 2000, 2002).

Successful development of a new wine style for a targeted consumer segment should consider not only the sensory attributes of the wine but also the psychological, sociological, and economical factors that affect consumer purchase behavior and dynamics of wine preference.

Perspectives for the Future

Sensory techniques are well documented and accessible in order to better characterize wine sensory properties, ensure wine quality, and develop new wine styles according to consumer flavor preferences; however, only large-scale wine operations have started to implement a sensory

program internally or to contract outside resources to do so. This limited establishment of sensory programs is a concern since the use of sensory practices can be highly beneficial to smaller operations by providing objective data rather than personal opinions for research and development, quality control, product and market development.

How can sensory professionals raise the awareness and confidence level of wine professionals for using sensory data in their business decisions? The first and immediate answer is to train more sensory professionals who can work with winery operations or act as external resources to advise winery employees on best sensory practices. In the current food and beverage industries there are not enough specialists available who are so trained, and positions tend to be taken by people who have received little formal training in sensory evaluation, if any (Frøst et al. 2005). Sensory evaluation is taught worldwide in most enology and viticulture programs at the university level; however, students seldom apply in their working practices what they have learned in their sensory course(s). Moreover, it is unfortunately that certain programs labeled as “wine sensory evaluation courses” in fact teach “wine appreciation” and not the sensory techniques associated with good practices of sensory evaluation as described in the literature (Lawless and Heymann 1998, Meilgaard et al. 1987). This is unfortunate because it can confuse the industry and the public about what are and what are not good sensory practices, and what are the true values and benefits of using sensory evaluation in winery operations.

Second, sensory professionals can enhance their communications skills when presenting sensory results to deliver reports that are more business oriented rather than methods oriented. And third, sensory professionals can ask wineries to conduct trials and use good sensory practices on smaller-scale projects to appreciate the complementarity of this information with traditional expert tasting. Many enology and food science students, trained in sensory evaluation, could contribute to such short-term projects.

New sensory methods are still needed to capture consumer attitudes toward wine. Preference mapping techniques describe consumers liking patterns for a given wine category at a given time and can predict the liking score of a new wine, based on its sensory profile, assuming the wine category remains consistent. However, personal preferences can change with time, as well as the wine category with the introduction of new wine styles. Thus it requires conducting preference techniques regularly to remain current with shifts in the marketplace.

In central location tests, consumers are requested to taste a product once or twice. In natural contexts of consumption consumers can have several sips from the same wineglass before making a hedonic judgment. It has been shown that astringency and bitterness can build up with repeated sips of red wine (Noble 2002) and that temporal profiles of bitterness and astringency of red wines could

affect consumer liking scores after repeated sips (Michon and Lesschaeve 2001). There is therefore a need to develop methodologies mimicking natural consumption behaviors when measuring consumer hedonic responses.

A new sensory methodology measures temporal dominance of sensations (TDS) in wine (Pessina et al. 2004). Results showed the additional value of TDS versus time-intensity measurements. Future studies are needed to assess consumer hedonic responses as a function of TDS profile of wines and evaluate the relevance of such measurement to predict consumer wine preference.

Quality control of wines aims first at rejecting wines tainted with undesirable flavors. Although zero tolerance of wine faults is the goal, it must be acknowledged that what is unacceptable for a wine expert can still be acceptable for some consumers. Prescott and colleagues proposed a consumer rejection threshold methodology to determine the level of taint at which wine is rejected by consumers (Prescott et al. 2005), and applied the method to 2,4,6-trichloroanisole (TCA) and later to *Brettanomyces*-tainted wines to demonstrate that the consumer was on average tolerant and less sensitive to taint than was an expert. Indeed, consumers rejected wines at a higher taint level than its detection threshold (3.1 ppt for TCA and 0.53–0.62 mg/L for *Brettanomyces* flavor). Knowing the taint concentration at which a wine is still acceptable for consumers has significant economic impacts in the search for remedial treatments when tainted wines are detected. Determination of the consumer rejection threshold for emerging taints such as the multicolored Asian lady beetle (*Harmonia axyridis*) (Pickering et al 2004) would ensure that acceptable wines could still be marketed while research is undertaken to design appropriate treatments to eliminate if not minimize the taint perception in the wine.

Conclusion

The conjoint development of new wine styles and marketing concepts is essential to ensure that consumer expectations created by the information on the label are not mismatched by the sensory experience of consuming the wine. The integration of sensory and market research approach is critical to ensure the production of wine styles according to both consumer flavor and sociodemographic segments.

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