SENSORY ANALYSIS

Learning Outcomes: *When Robert Parker, the noted wine critic, awarded a record 19 wines with a perfect score for the 2009 Bordeaux vintage recently, the wine investment market reacted quickly, with some wines trading at high prices almost instantly. However, research suggests that professional wine critics have very different tastes than consumers, leading some to suggest that investors should take wine scores with a pinch of salt. The following is designed to provide a general background about sensory evaluation to individuals in the wine industry. It is intended as a general review of sensory evaluation, not a comprehensive resource, but will provide adequate information to help winemakers and prospective winemakers understand the importance of sensory evaluation in the wine industry.*

Chapter Outline

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Section 1.

Overview of Sensory Evaluation

"*There are no standards of tasting in wines, cigars, poetry and prose. Each man's own taste is the standard, and a majority vote cannot decide for him or in any slight degree affect the supremacy of his own standard*." – Mark Twain, 1895

We can agree on science, but only when we understand the basic principles. Sensory evaluation is used throughout the winemaking process to aid in decision making. To ensure that production decisions are made, based on an understanding of true sensory differences, it is vital that assessments be performed in a suitable manner.

Sensory evaluation is a scientific discipline used to evoke, measure, analyze, and interpret reactions to the characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing (Institute of Food Technologists, 1981). Without the proper sensory evaluation techniques, it is difficult to interpret sensory responses and make logical and sound decisions.

More than 1000 compounds have been identified in grapes and wine, with individual concentrations varying considerably. Our ability to perceive compounds is dependent not only upon their presence at or above a sensory threshold concentration, but also upon their interaction with other components. The sensory properties of a particular wine, therefore, are dependent upon chemical and physical effects relating to the specific matrix or composition.

For example, aroma/flavor compounds can bind with macromolecules, such as tannins, proteins, and polysaccharides, impacting volatility and, therefore, our ability to perceive them (Kennedy et al., 2010). The stability and solubility of these colloids (small, usually eclectically-charged particles) is likely variable. However, shear forces during operations, such as filtration, may disrupt these colloids. Colloid disruption might help explain bottle shock, or the change or loss of aroma/flavor intensity immediately post-bottling (Kennedy et al., 2010).

Two aroma compounds in isolation may be clearly noted; in a mixture, however, they can mutually suppress each other. In such a circumstance, one compound may dominate the other to such a degree that the second is not perceived at all.

When many aroma compounds are present together, as in a wine, the complexity is such that it is virtually impossible to predict the extent of the suppression effects, or to know what compounds will be more dominant. While suppression is the most common circumstance, in some cases aroma compounds can enhance each other, even if both are below the detection threshold.

Masking occurs with dimethyl sulfide (DMS), a volatile sulfur compound variously described as having a cabbage/cooked corn/truffle aroma at high concentrations. At sensory threshold concentrations, DMS can add to fruit intensity of red wines. This compound increases with bottle age (Siebert et al., 2010), and may help explain the relative complexity of aged wines versus younger products.

We often use compositional information to help ensure that a wine is sound and complies with TTB regulations. For example, monitoring a parameter like 4-ethylphenol is routine, with the goal of providing objective, direct information on soundness of the product. However, due to the matrix effect (the impact of other wine components on the volatility of 4-EP), it is not possible to state with assurance the level of 4-EP below which a wine will not have a Brett character and will appear sound.

The matrix effect is evident in routine cellar operations. Fining with protein and bentonite is used to remove unwanted proteins and phenolics from wine. Winemakers know that these agents can also change the aromatic properties of wine as a result of these complex interactions, as can the addition of lees, enological tannins, etc. Thus, simply quantifying aroma compounds does not provide sufficient information to predict aroma properties (Rodriguez-Bencomo et al., 2010).

The wine industry has historically relied on “experts” for determination of sensory characteristics of wine. Evaluation of wine by such “experts,” highly trained to evaluate the slightest nuances in flavors and aromas, may be valuable to a winery, providing detailed descriptions of differences in wines.

However, problems can occur if too much reliance is placed on a few individuals making sensory judgments that influence production or marketing decisions. “Expert” opinions may not be reflective of true sensory characteristics, or those important to the wine consumer. External factors such as mental or physical fatigue or distractions can interfere with the “expert’s” analysis of the product.

If a few “experts” are the common means of sensory evaluation within a winery, limitations of these evaluations are significant. A progressive winery will understand the importance of basing decisions on sensory data that can be statistically evaluated and interpreted.

In a competitive environment, it is important to base decisions about wine, new products, and wine improvements on the best information possible. Sensory evaluation controls the external variables as completely as possible, so that only the variable of interest is being measured. Sensory results can be interpreted statistically, providing a basis on which decisions can be made. Effects of changes in processing conditions on sensory attributes can be measured and the impact of the processing decision weighed.

Sensory evaluation of wines can also assist in relating sensory impressions to others in a meaningful way, by establishing a standardized sensory vocabulary. Correlation of sensory analysis with chemical measurements of selected wine compounds can assist in interpreting chemical data relative to wine characteristics. Properly-conducted sensory evaluations can lead to improved decision-making with less risk involved, a means to targeting and achieving goals, and a way of categorizing attributes.

The selection of a sensory evaluation method is determined based on the type of information that is needed. A new grape variety, variations in pressure during pressing, or a change in yeast strain or supplier, can lead to changes that may impact on the sensory characteristics of the wine. It may be important to know if there are perceptible changes, what those changes are, and the impact of those changes on the consumer's perception of quality or acceptance.

Relevance of Wine Components in Sensory Analysis

Wine balance can be viewed as the reciprocal-type relationship indicated below. An increase in the perception of components on the left side causes a decrease in the perception of components on the right.

Sweet/Body ↔ Acid + Phenols (tannin intensity, astringency, dry tannins and bitterness)

Palate balance is impacted by a number of features, including temperature:

- Cooling reduces sweetness of sugars.
- Cooling reduces bitterness of alkaloids.
- Cooling increases the sense of acidity.
- Cooling increases bitterness and astringency of tannins.

Wineries generally serve all their whites at one temperature, and all their reds at another. Based on the palate-balance relationship, this may not be optimal.

Sugars

Sugar concentrations above 0.2% are generally required for a wine to exhibit perceptible sweetness. When sweetness is detected in dry wines, it is usually due to the presence of a noticeable fruity fragrance. Association between fruity odors and sweetness has trained us to instinctively affiliate the presence of fruity odors with sweetness, even in its absence (Prescott, 2004).

Sugars begin to have a pronounced influence on sweetness and affect the perception of body at concentrations at or above 0.5%. The influence of aromatics on the perception of the sweetness of sugar can be very important. Thus, the fragrance of a wine may not only evoke the perception of sweetness, but also increase the perceived intensity of sweetness. This can be important in rosé wine production.

Body

Despite the importance of body to the overall quality of wines, its precise origin remains unclear. Gawel et al. (2007) found a correlation between higher ratings for flavor and/or perceived viscosity with body. In sweet wines, body is often viewed as being roughly correlated with sugar content. In dry wines, it has often been associated with alcohol content.

There is evidence that the macromolecular content of wines (yeast proteins and polysaccharides) may play a role in the overall perception of body (Vidal et al., 2004a, b). Features such as a wine's fragrance can influence the perception of body and, conversely, increasing the sugar content can increase the perception of fragrance.

Polysaccharides

Polysaccharides, either grape- or yeast-derived, play a role in reducing acidity and astringency. They add to the perception of sweetness/body and thus lower the perception on the other side of the palate balance relationship. This influence can be significant, and is the basis for the interest in yeast fining, and in some commercial addition products.

Alcohol

Ethanol possesses a sweet aspect. Ethanol slightly enhances the sweetness of sugars, while reducing the perception of acidity. At high concentrations (above 14%), alcohol increasingly generates a burning sensation, and may contribute to the feeling of weight or body, especially in dry wines.

Acids

The effect of acidity in diminishing perceived sweetness appears less than that of sugar in suppressing the perception of acidity (Ross and Weller, 2008). Of the common acids found in wine, malic acid is the most sour tasting, whereas lactic acid is generally considered the least sour.

The perceived intensity of a mixture generally reflects the intensity of the dominant component, not a summation of their individual effects (McBride and Finlay, 1990).

pH also impacts taste perception, both directly by influencing the ionization of salts and acids, and indirectly by affecting the shape and biological activity of proteins. Structural modification of receptor proteins on tastebuds could significantly affect taste responsiveness.

The use of oral hygiene products can impact tastebuds, making most wines taste much more of acidity. The so-called Orange Juice Effect is the result of sodium lauryl sulfate (or sodium dodecyl sulfate, two names for a common toothpaste ingredient) that can react with taste buds (DeSimone et al., 1980). This is a primary reason why sensory evaluations are generally not conducted too early in the morning.

Saltiness

The salt of some cheeses can suppress the bitterness of red wines. These influences may or may not affect response time, duration, and maximum perceived intensity.

Mouthfeel

Mouthfeel is a generalized term used to describe the multiple sensations of the following:

- astringency
- touch
- viscosity/body
- burning
- temperature
- prickling from carbon dioxide
- pain

The combination of these sensations with those from the nose produces the perception of flavor. Unlike gustatory (taste) and olfactory (smell) sensations, mouthfeel activation occurs slowly, and adaptation is also slow or may not develop. The latter is particularly evident in the increased intensity of astringent sensations on repeated exposure to red wines, consequently, the recommendation for the use of palate cleansers during tasting.

Taste- and mouthfeel-components can affect taste:

- Ethanol enhances the perception of sugar-induced sweetness.
- Ethanol suppresses the astringency of tannins.
- Ethanol enhances flavonoid-induced bitterness (Noble, 1994) when the alcohol level is relatively high.
- Acids increase the perception of bitterness and astringency.

Astringency and Bitterness

Astringency (puckeriness) is primarily induced by flavonoid tannins that come from grape seeds and skins. Anthocyanins can enhance the perceived astringency of tannins, but do not contribute to wine bitterness (Brossaud et al., 2001).

Both astringency and bitterness perceptions develop comparatively slowly and possess lingering aftertastes. Astringency may partially mask bitterness (Arnold and Noble, 1978), and is more often confused with bitterness than the inverse.

Astringency is thought to result from the binding and precipitation of proline-rich salivary proteins and glycoproteins with phenolic compounds. pH affects protein hydration, and ionization of both phenol and protein.

Astringency is one of the slowest in-mouth sensations to develop. Depending on the concentration and types of tannins, astringency can take up to 15 seconds before reaching maximal intensity. The decline in perceived intensity occurs even more slowly.

The intensity and duration of an astringent response often increases with repeat sampling (Guinard et al., 1986). This phenomenon is less likely to occur when the wine is consumed with food, owing to reactions between tannins and proteins in the food, as well as due to dilution.

Mouthfeel time intensity characteristics include the following:

- Activation occurs slowly.
- Adaptation occurs slowly, as evidenced by increased intensity upon repeated exposure.
- Astringency intensity and duration often increase with repeated exposure.
- Interaction of salivary proteins can be blocked by incorporation of lees peptides and other sulfur-containing side groups.

Molecular size is one of the more important factors influencing tannin-induced astringency. Bonding is roughly correlated with molecular size (polymerization). Steric hindrance (molecular geometry) limits the availability of some binding sites.

Phenol features and relationships include the following:

- Lower pH equates to higher perception of astringency.
- Higher alcohol generally lowers perception of astringency and increases perception of bitterness.

- Increased polymerization augments drying, chalky, grainy, puckery attributes.
- Increased galloylation (flavonoids esterified with gallic acid) augments rough or coarse attributes, as well as dryness (Vidal et al., 2003); galloylated tannins are common in seed tannins.
- Velvety astringency in reds is positively correlated with flavonol glycosides.
- There is a positive correlation between color and perceived tannin "quality."
- Incorporation of anthocyanins terminates tannin polymerization.
- Generally, greater color is correlated with finer tannins.
- Flavanone glycoside and tyrosol produced by yeast contribute to the slight bitterness of white wines.

Phenols can often have more than one sensory response. In mixtures, this can significantly affect overall taste quality. For example, small tannins (small molecular weight polymers) may be both bitter and astringent.

The interaction of taste and mouthfeel components forms the basis of food and wine pairing. For a discussion of food and wine pairing exercises you can conduct at the winery with your clients, see Food and Wine Pairing at www.vtwines.info.

Additionally, for examples of how to determine wine preferences with regard to taste and mouthfeel elements, go to www.yumyuk.com and take the Taste SQ interview.