

Wine quality and consumer preferences: understanding consumer needs



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INTRODUCTION

The wine industry has at its heart the production of an alcoholic beverage that is appreciated for its attractive taste and diversity of aromas and flavours. Wine is a drink that can be light and subdued in flavour, or complex, intense and rich, and has a wide range of possible flavour characteristics compared to many other drink products. In addition, for many people, wine is more than just a pleasant drink, and for them there is an intellectual component in learning and appreciating the differences among wines. With some experience, the novice will come to learn that different varieties can taste distinctly different. They will realise that there can be a range of flavours in wines produced from the same variety but grown in different regions or arising from different winemaking methods; and that the sensory properties can be markedly different from vintage to vintage of the same wine, or in the same wine as it is cellared over time. Notwithstanding the often fascinating intellectual and emotional aspects of wine appreciation, there will always remain the basic question, as with all foods and drinks, as to how much do I like this wine?

For highly experienced wine industry personnel, notably winemakers, the related question regarding “how good is this wine?”, is answered according to quality criteria obtained by a large amount of experience tasting wines with their peers and aligning concepts of what makes a good example of a style or variety. Each winemaker will have a ‘gold standard’ ideal wine or wines in mind when assessing a set of samples, arising from the totality of their experience and expectations in wine evaluation. This ‘gold standard’ will usually not be consciously articulated but in some cases it may be, for example, in a wine show context, or when a group of company winemakers are conducting grading post-vintage tastings. In these cases, the best wines will be discussed as meeting or not meeting the explicit or implicit ‘gold standard’ requirements and to what degree. The ‘gold standard’ will often encompass some objective elements, that is, the wine meets certain sensory specifications (e.g. not perceptively sweet, full-bodied, free of bitterness, free of agreed defects

or faults); but also can have a strong subjective element, possessing levels of perceived characteristics that the winemaker prefers.

Making wines that will be appreciated by wine drinkers who do not possess such a breadth of experience, and who generally lack the ability to describe sensory properties, then requires judgement by winemakers of what the market prefers. The judgement by a winemaking and marketing team regarding what wine styles to produce, or how to adjust an existing wine brand to improve sales, will often involve assessment of competitors’ wines, including those that are market leaders. The winemaking team may try to ascertain whether the consumer prefers more or less acidity, residual sugar, wines with riper or less ripe flavours, degree of oak flavour, and all the other myriad options open to the modern winemaker. The style preference of the winemaker will also have a bearing on these decisions. For companies intending to release a product that is new to the company portfolio, there will often be a strong element of ‘flying blind’, either producing a wine that is a ‘me-too’ type product, or risking launching a wine brand that might not meet consumer expectations.

QUALITY AS DEFINED BY CONSUMERS

The term quality can have innumerable definitions applied to it, but a general definition from the International Standards Organisation (Standards Australia 2001) is the “degree to which a set of inherent characteristics fulfils requirements”. For wines, the inherent characteristics include the sensory properties: how the wine appears in the glass, how it smells and most importantly how it tastes. There can also be non-sensory attributes of importance to how well a wine fulfils requirements, notably price, but also details like brand reputation and familiarity, bottle shape and packaging.

For winemakers to gain an appreciation of consumer’s perception of quality, it is desirable to determine in as reliable and straightforward a manner as possible what are the sensory characteristics that consumers value. Linking

sensory production characteristics to consumer requirements would allow informed decisions to be made in new product development and to align an existing wine brand or style to optimal consumer preference. For example, testing to answer whether, in a given wine, consumers prefer a titratable acidity (TA) of 6.0, 6.3 or 6.5 would give much greater confidence that a wine will not fail upon launch. This is indeed what is done in other food and beverage industries (Stone and Sidel 2004).

CONSUMER TESTING

Regarding the ISO definition of quality quoted above, when we consider what quality means to wine consumers, it is apparent that most consumers are not able to easily express or describe what characteristics they like or dislike (Stone and Sidel 2004). Even for experienced winemakers, this can be a difficult task, and requires switching a frame of reference from a global or overall impression to an analytical way of thinking. For most of us when eating or drinking, we are not thinking analytically about the different characteristics that make up the experience, and don't consciously weigh up whether, for example, an orange juice is of high or low quality, but rather whether we like or dislike the flavour. Similarly, for most consumers it is straightforward to make a judgement regarding how much they like a wine. Thus, of the two elements of the ISO definition, consumers are good at assessing whether a wine fulfils requirements, that is, how much they like it on a subjective basis, but are not readily able to provide information about the characteristics they value or don't value. If consumers are asked to say why they like or dislike a wine, they must change their way of thinking to a much more analytical viewpoint, becoming much less like a typical consumer in a normal consumption situation. Equally importantly, consumers will, when trying to communicate characteristics, use a wide range of words that might be more or less interpretable, and these aspects might or might not be in fact important to their liking decision. For example, if a consumer said a wine was too dry, it is difficult to know if this is related to excessive acid, too much tannin, too little fruit flavour or too little sweetness.

Another common observation regarding consumer behaviour is that consumers are highly variable in their responses; which is not surprising as they are 'untrained' and subject to numerous influences. Also, it has been found that consumer preferences do not usually agree with expert or manufacturers' judgements on quality.

Consumer testing has been carried out systematically in a scientific and rigorous manner since the 1950s or even earlier, and extensive studies have been completed to find

optimal methods for assessing consumer preferences. Established methods have arisen from the results of numerous research projects in foods and beverages assessing the many possible variables involved in such testing. Accepted practice for consumer testing includes several simple but important principles:

- **Recruit 'users' and 'likers'**
For a wine study, consumers who regularly purchase the wine style and who generally enjoy such wines should be recruited: people who dislike the style, or who have never tried the type of wine would give responses that are not representative of people who would buy the product.
- **70-200 people from target population**
The number of consumers needs to be fairly large to allow differences between samples to be determined given the variability among consumers. The selection criteria can be broader or narrower depending on the study: for example, recruiting people who spend frequently at a certain price point, or targeting older people with longer experience as wine drinkers.
- **Blind tasting**
Wine should be tasted with no knowledge about the producer, reputation, price or other extraneous factors: sensory liking should be measured solely on the basis of how the wine tastes.
- **Good sensory practice**
Usual standardised sensory evaluation methods such as three-digit random number coded glasses, isolated booths, constant serving temperature, a small number of samples presented per session and randomised serving order across tasters are very important to reduce or remove biases and 'noise' inherent in sensory tests of any type, including consumer testing.
- **Samples presented one by one**
A rest between samples reduces sensory 'fatigue' and is considered a more realistic simulation of how wines are tasted in a social context.
- **Simple 'hedonic' degree of liking scale**
A simple, well-understood liking scale such as the well known nine point 'hedonic' scale (Figure 1) allows discrimination among wines.

Regarding the second element of the ISO definition: defining those characteristics that a consumer might value or which might result in rejection, this is accepted as being best achieved by using a trained sensory panel comprising people who can reliably rate the intensity of appearance, aroma and palate characteristics but who give no



Figure 1. The nine-point hedonic scale.

preference or quality judgements – the panel is simply used as a measuring instrument. The AWRI has a long history of running such panels, which themselves require numerous controls and a high degree of care and professionalism to achieve reliable, accurate, meaningful and valid results.

Having carried out a consumer study, obtaining both consumer testing and trained sensory panel data, relating the two sets of data allows an extremely powerful means of defining wine quality. If winemaker grading judgements are obtained as well, this allows an even better ability to understand the complex issue of what constitutes a quality wine.

In wine research, there have been few studies that have utilised consumers for sensory acceptance testing, and very few wine companies have, to our knowledge, applied these techniques. A research study investigated consumer preference for acidity in a set of German Riesling wines (Fischer 2000), and there have been several reports of wine preference mapping studies carried out in the USA (Yegge and Noble 2001, Frøst and Noble 2002, Lesschaeve *et al.* 2002). An experimental design approach was used to assess wine compositional variables on consumer liking (Hersleth *et al.* 2003). Currently little wine consumer sensory testing is carried out in Australia, either by wine companies or by the research community. At the AWRI recently, our first consumer testing study was carried out with Riesling and unwooded Chardonnay wines (Francis *et al.* 2005, Lattey *et al.* 2005).

DEFINING QUALITY OF AUSTRALIAN CABERNET SAUVIGNON AND SHIRAZ WINES

An AWRI study was recently completed, with the main aim of the study being to assess which sensory properties of red wines most influence consumer preference. It was also of interest to assess whether Cabernet Sauvignon wines might be liked differently to Shiraz wines, and how winemakers' judgements of quality relate to consumers' preference.

A set of 20 commercial red wines, consisting of 10 Shiraz and 10 Cabernet Sauvignon wines, were carefully selected for the study as representing examples of the major wine types made in Australia. The wines included examples of (i) peppery cool climate Shiraz; (ii) herbaceous/greener Cabernet Sauvignon; (iii) riper styles; (iv) those with strong oak influence; (v) less flavourful wines; (vi) astringent wines; (vii) wines with *Brettanomyces* flavour; and (viii) wines with some sweetness. Wines from across the major Australian viticultural regions, and made by both large companies and smaller producers were included. Sales data were taken into consideration in the selection, as was the basic chemical composition of the wines.

Sensory characteristics

The 20 wines were subjected to sensory descriptive analysis by a trained AWRI sensory panel and the sensory properties were quantified in triplicate. From the sensory data obtained, a subset of 12 wines was selected for consumer testing. A subset of the total was selected partly because consumer testing with large numbers of people is expensive, but also to

TABLE 1. DETAILS OF WINES INCLUDED IN THE CONSUMER TESTING.

Cabernet Sauvignon

Wine code	Vintage	Region	Retail price	Alcohol (%v/v)	pH	TA ^a (g/L)	VA ^b (g/L)	Glucose+ Fructose (g/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)
Cabernet Sauvignon										
CS1	2002	Yarra Valley	\$22	12.5	3.53	5.8	0.61	0.3	16	55
CS2	2002	Coonawarra	\$24	13.5	3.44	6.3	0.71	0.2	13	44
CS3	2003	South Eastern Australia	\$10	13.7	3.51	6.0	0.54	0.5	13	35
CS4	2003	Barossa Valley	\$21	14.9	3.54	6.4	0.68	0.7	13	44
CS5	2003	Coonawarra	\$25	14.4	3.36	6.8	0.59	0.5	10	44
CS6	2003	Clare Valley	\$14	14.5	3.47	5.9	0.74	0.7	14	49

Shiraz

SH1	2002	Hunter Valley	\$17	14.6	3.48	5.6	0.66	0.6	5	38
SH2	2002	Macedon Ranges	\$23	14.5	3.42	6.4	0.62	0.7	15	64
SH3	2003	South Eastern Australia	\$9	13.8	3.53	5.8	0.60	7.1	8	23
SH4	2003	Coonawarra	\$17	12.5	3.56	5.7	0.61	0.9	26	66
SH5	2003	Barossa Valley	\$28	14.9	3.55	6.7	0.67	0.8	17	54
SH6	2003	McLaren Vale	\$13	14.2	3.55	5.4	0.60	0.4	18	56

^a Titratable acidity; ^b Volatile acidity.

ensure that wines that were sufficiently different in sensory properties were identified; there is little value in a study of this type in presenting very similar wines to consumers.

The 12 wines that were selected are listed in Table 1, including data of some of the basic chemical compositional variables. Two wines were deliberately selected with a lower alcohol level (wines CS1 and SH4), and one wine had relatively high residual sugar (wine SH3). The titratable acidity of the wines also varied, from 5.4 to 6.8 g/L.

While wines from different regions were obtained, the reader should not assume that the wines are necessarily representative of typical wines from each region. With only one or two wines selected from each region this study was by no means intended as a survey of Australian winegrowing areas. Notably, as mentioned above, two 'Brett' affected wines were selected, and these could have been sourced from almost any region.

With regard to the sensory properties of the wines obtained from the trained panel, representing the sensory data in a meaningful way is difficult with such a varied sample set which includes intensity ratings for multiple sensory attributes. Figure 2 shows a summary of the sensory data in the form of a colour map: those attributes indicated by deep red were rated highest in intensity for particular wines and the attributes rated as low in intensity are indicated by deep blue. The intermediate low ratings are paler blue, and intermediate higher ratings are shades of red. Note that to simplify the picture somewhat, not all sensory properties rated by the panel are shown in Figure 2, only those that discriminate the wines to the largest extent. The wines are also grouped so that wines with similar sensory profiles are adjacent to each other.

It can be seen that for wine SH1 all attributes were rated as low except for *bandaïd* aroma and relatively high bitter taste. The *bandaïd* attribute was rated highest in this wine of all the wines in the study. The wine CS2 had a similar profile, being rated as high in *bandaïd*, and lower in most other attributes,

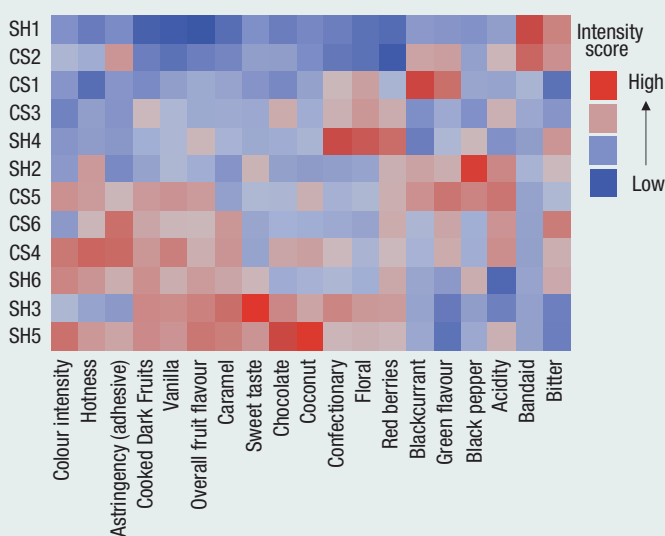


Figure 2. A colour map representation of a subset of sensory attributes rated by a trained sensory panel for the 12 Shiraz and Cabernet Sauvignon wines. The gradation of colour from low (deep blue) to high (deep red) indicates the relative intensity of each attribute for the wines; that is, high for one attribute might not equate to high for another. For details of the sample codes see Table 1.

but was also rated as moderately high in *astringency*, *blackcurrant* and *green flavour*. The wines CS2 and SH1 were rated similarly highly for other *Brettanomyces* related characters, such as *leather* and *barnyard* (not shown), and these wines were in fact high in 4-ethylphenol concentration: 1800 and 1400 µg/L respectively. All other wines in the study had less than 300 µg/L of 4-ethylphenol concentration.

Wines CS1, CS3 and SH4 were rated relatively low in the attributes *colour intensity*, *hotness* and *astringency* (Figure 2), with SH4 showing higher perceived *confectionary*, *floral*, and *red berries* attributes, and CS1 rated highly in *blackcurrant* and *green flavour*. Wine SH2 was rated by the sensory panel as highest in *black pepper* aroma, while CS5 was intense in many attributes, notably *colour*, *hotness*, *dark fruits*, *fruit flavour*, *vanilla*, *coconut*, *blackcurrant*, *green flavour* and *acidity*. CS6 was rated highest in *astringency* and *bitterness*, and intermediate in most other attributes. Both CS4 and SH6 were rated high in *colour*, *hotness*, *astringency* and *caramel*, with CS4 also rated higher in *chocolate*, *coconut*, *green flavour* and *acidity*, and SH6 scored as higher in *red berries*. SH3 and SH5 had similar profiles on the attributes *vanilla*, *caramel*, *chocolate* and *coconut*, with SH5 also rated highly in *colour*, *hotness* and *astringency*, and SH3 rated high in *sweetness*. SH3 was the single wine selected with residual sugar (7 g/L, Table 1).

Having established and quantified the range of sensory properties of the wines, the next stage of the study was to assess how well the wines were liked by consumers and how they were scored for quality by winemakers.

CONSUMER TESTING

A group of 203 consumers based in Sydney were asked to rate the degree of liking of the 12 wines on the nine point hedonic scale. The consumers were recruited and tested by the company SensoMetrics, under AWRI direction. The selection criteria included the stipulation that equal numbers of males and females were to be tested, with equal numbers of older and younger people, all regular red wine drinkers (greater than once per week), who frequently spend up to \$30 per bottle. Six wines were presented blind to each consumer in two sessions held on two consecutive days, with one wine presented at a time, and a five minute rest between wines. All wine bottles were screened by AWRI for cork taint and oxidation before being presented to the consumers.

Demographic information was also obtained from the consumers and is shown in Figures 3a-d (on following page). There were 104 males and 99 females tested, and approximately the same numbers of older and younger people, with most being consumers of wine for more than ten years. As a group, they were frequent wine consumers and commonly spent \$9-\$20 a bottle (Figure 3c and d).

A number of attitude questions were asked as well, including self-reported wine knowledge (Figure 3e). Most of the group indicated they had some knowledge but did not consider themselves enthusiasts. A question asking the participants to rate the relative importance of variables on the decision to purchase indicated that grape variety was of greatest significance, with medals on the bottle or closure type being of lesser importance (Figure 3f).

Of the 203 consumers who took part in this study, only 22 could correctly identify what a 'corked' wine was when given a choice of seven options. Of those consumers who correctly selected the 'wine smells musty or mouldy' option, two reported to 'never' have noticed a 'corked' bottle either at home or away from home, while 16 responded as 'rarely' and four as 'occasionally'; with none saying they 'frequently' encounter this issue. A surprising 81 consumers selected the incorrect option that a 'corked' wine has resulted because 'cork has allowed air/oxygen into the wine to spoil it'.

In relation to their perception of a closure's connection to low or high quality wines, consumers were asked to rate their attitude towards each of natural cork, screw-cap and synthetic closures on a continuous line-scale. Natural cork was significantly associated with the highest quality wines.

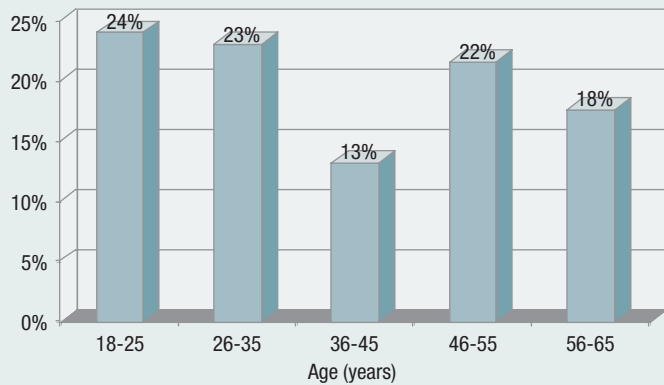
Consumers were also asked for their preferred closure for white and red wines with the options of choosing 'don't mind', 'natural cork', 'screw-cap' or 'synthetic cork'. For white wine, 38% of consumers chose 'don't mind'; 25% selected 'natural cork'; 31% chose 'screw-cap'; with the remaining 6% selecting 'synthetic cork'. There was a different pattern observed for red wines, with 58% of consumers indicating natural cork as their preferred closure; 'don't mind' and 'screw-cap' received approximately equal levels of responses; with synthetic corks only preferred by 2% of the consumers.

When asked whether consumers had heard about the wine fault 'Brettanomyces' or 'Brett' only ten consumers responded 'yes'.

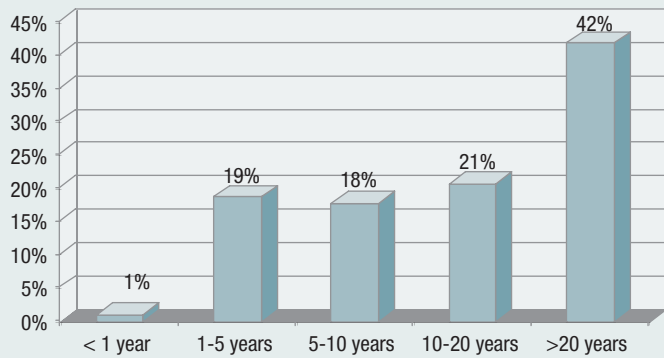
CONSUMER LIKING

The mean liking data from the consumers for the 12 wines are shown in Figure 4. The Least Significant Difference (LSD)

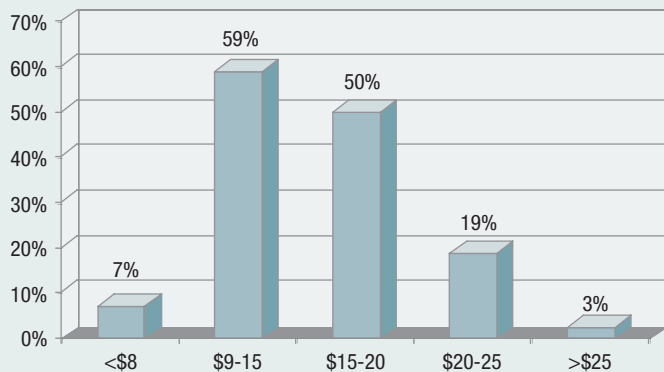
(a) Age distribution of consumers in the study



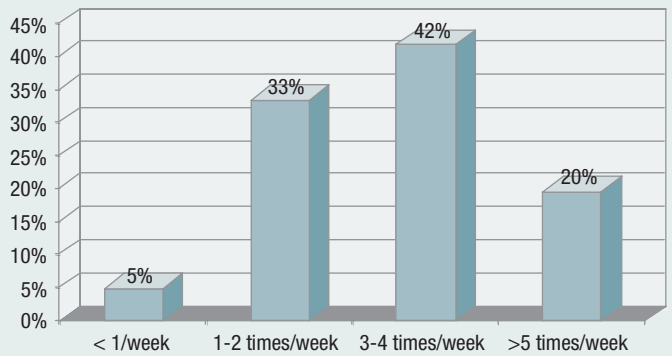
(b) How long have you been drinking any type of wine?



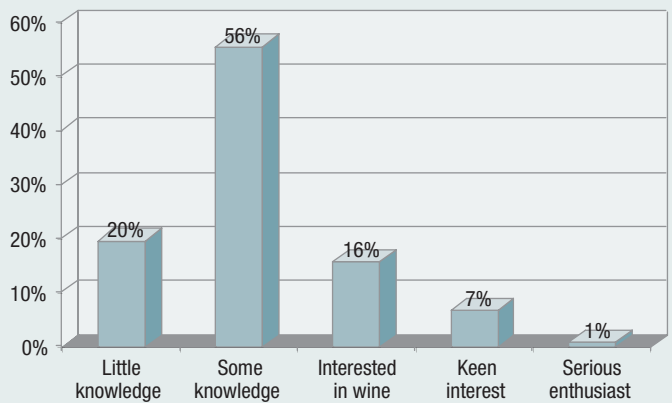
(c) How much do you frequently spend per bottle?



(d) During an average week, how often do you drink wine of any type?



(e) Which best describes your level of wine knowledge/interest?



(f) Relative importance in decision to purchase

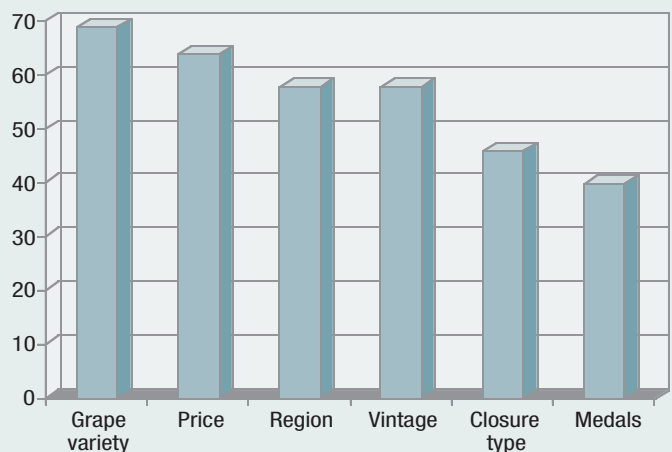


Figure 3. Consumer demographic and attitudes data.

value is also shown, providing an ability to assess how far apart the means should be, to be considered significantly different. The first thing to note about the data is that on the whole all the wines were generally liked, with mean scores above five on the nine point scale. There was no systematic pattern in liking between the Cabernet Sauvignon wines and the Shiraz wines, with both varieties receiving a similar range of scores and the two most liked wines being an example of Shiraz (SH3) and Cabernet Sauvignon (CS1). These two wines had different sensory profiles as discussed above and seen in Figure 2, and had quite different retail prices (\$9 for SH3, a large company wine and one of the top selling Australian Shiraz wines, and \$22 for CS1, a medium-sized company wine and not a market leader), but common features of the wines included low ratings for *colour intensity*, *botness*, *astringency*, *bandaid*, *pepper*, *acidity* and *bitterness*, and moderately high ratings for *confectionary* and *floral* (Figure 2). The least liked wines included the two strongly *bandaid*/Brett-affected wines SH1 and CS2, and the strongly *peppery* wine SH2.

A striking feature of the data in Figure 4 is the large standard deviation of each of the wines, including the least liked wines, showing that there was a wide diversity of liking responses in the tested consumers. Some wines, such as SH4, had somewhat smaller standard deviations than others, but all wines were strongly liked by some consumers and less liked by others.

Cluster analysis on the data showed that the consumers could be grouped into segments who behaved similarly,

generally liking and disliking the same wines. Five distinct groups were indicated, including a very small outlier group of three people who liked only one wine, wine SH3, and rated all other wines with low scores. This small cluster was not considered further in the data analysis. The other four clusters comprised varying proportions of consumers, with the largest cluster including 45% of the consumers, or 90 people, with two others including 19% and 21% respectively, and the smallest cluster comprised 15% of the consumers.

Figure 5 shows the mean data for each of the four clusters. The consumers of the four identified clusters had different patterns of liking responses for the 12 wines. Clusters 1 and 2 rated the wines generally lower, but with a wider range of responses, from around 4 to 7 on the nine point scale, compared to the other two clusters, who rated all wines within a point. Cluster 1 gave the highest acceptability scores for SH3, SH5, and CS6; wines that had similar 'fruit' attribute sensory profiles (Figure 2). Cluster 2, interestingly, rated all the Cabernet Sauvignon wines as most preferred, with the exception of CS6. No other cluster had a preference by variety. Cluster 3 consumers liked the SH3, CS1 and CS3 wines most, and disliked SH2. SH2 was also least liked by Cluster 4, the largest group, who in common with the Cluster 3 consumers, liked most the wines SH3, CS1 and CS3 but in addition CS5, SH4, and SH6 were also liked by this group. All groups, with the exception of Cluster 2, rated SH3 amongst their most liked wines, and similarly all groups, except for Cluster 1, highly liked wine CS1.

Internal preference mapping was used to investigate the relationships between the sensory properties and liking for the consumer groups. Figure 6 shows the same data as provided in Figure 5, but allows the sensory attribute rating data to be superimposed. As discussed above, wines SH2, SH1 and CS2 were less liked by all clusters, indicated by the vectors pointing away from these wines, but there were clear differences among the clusters, and in this representation of the results we can determine what sensory properties were driving preferences, that is, which were most important to the four groups' likes and dislikes. This is indicated on Figure 6 by the position of the sensory attributes. Those attributes close to a vector are positively related to the liking of a

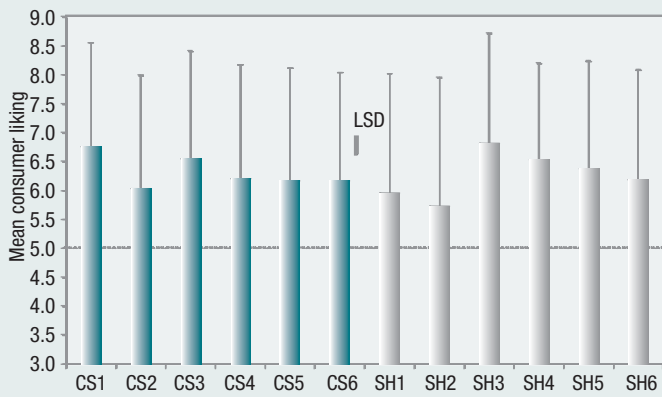


Figure 4. Mean consumer liking scores from the 203 consumers for the 12 red wines. The solid black bar is the LSD: Least Significant Difference (P=0.05). The error bars are one standard deviation.

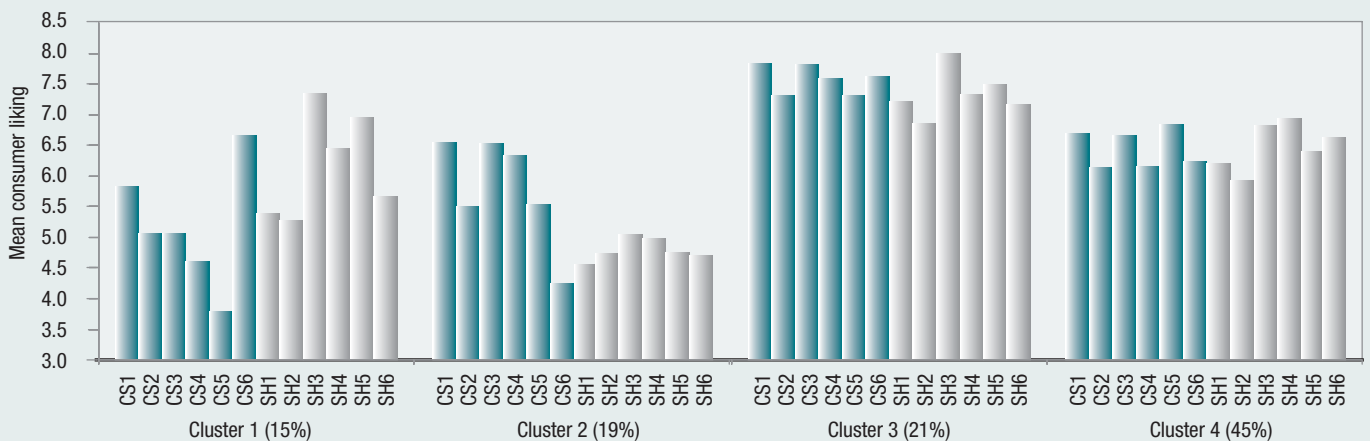


Figure 5. Mean consumer liking scores for the four consumer clusters for the 12 red wines. For details of the sample codes see Table 1.

cluster, while those attributes situated in the opposite direction away from the vectors, are negatively associated with liking of that cluster.

Figure 6(a) shows that Cluster 2 consumers preferred the Cabernet Sauvignon wines, as indicated by the arrow for this cluster pointing in the direction of five of the six Cabernet Sauvignon wines, and these wines were the strongest in *green* (capsicum/green bean) flavour, *fresh green* aroma, *blackcurrant* flavour, *mint* and also *acidity*. All of the Shiraz wines were liked approximately equally by this group, and the main factor that differentiated the acceptability of the Cabernet Sauvignon wines for the consumers comprising this cluster was the degree of *bitterness*.

Cluster 1 consumers most liked wines SH3, SH5, SH4 and CS6, and the liking of the consumers comprising this group was most positively associated with the attributes *caramel*, *confectionary* and *sweetness*, and the wines they disliked were stronger in *acidity*, as well as in *pepper*, *earthy*, *bandaid* and *barnyard* aromas. Cluster 3 and 4 liking was most strongly driven by the attributes *confectionary*, *overall fruit flavour*, *floral*, *red berries* and *cooked dark fruits*, and wines with *bitterness*, *pepper*, *smoky*, *metallic*, *bandaid* and *barnyard* not liked. Cluster 4, the largest group of consumers, had broadly similar responses to Cluster 3 consumers, but with some important differences. Figure 6(b) shows that the largest positive influences on liking for Cluster 4 were the attributes *confectionary*, *red berries* and *floral*, with negative

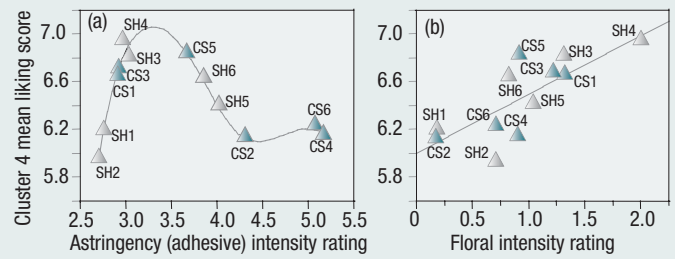


Figure 7. Relationship between Cluster 4 liking score and (a) astringency (adhesive) and (b) floral intensity rating from a trained sensory panel. Lines of best fit are shown.

influences being *smoky* and the astringency attributes (*coarseness*, *drying* and *adhesive*). The latter attributes were the only ones that displayed a non-linear response with liking for any cluster. Figure 7 (a) shows the relationship between astringency (adhesive) and liking for this cluster, indicating clearly that those wines with intermediate astringency were most liked by these consumers. Figure 7 (b) shows the significant linear correlation between *floral* aroma and liking for this cluster.

Having identified four clusters, statistical analysis was conducted to determine what types of consumers made up each group. There were found to be no differences among the clusters in most demographic categories, including age, gender, marital status, income, level of education, employment category, country of birth/ancestry, self-reported wine experience, place of purchase, wine consumption occasion, or frequency of wine drinking. There was however a significant difference among clusters according to the number of years the participants had been drinking wine. Cluster 4 had statistically significantly more people who had been drinking wine for more than ten years than the other clusters, and there was a trend (Table 2) for the Clusters 1 and 2 to have a greater proportion of consumers who had been drinking wine for a shorter period. Interestingly, this was not related strongly to age, although there was a trend for a higher proportion of Cluster 1 and 2 consumers to be in the 18-35 age bracket (Table 2).

WINEMAKERS' QUALITY SCORES

Quality scoring data of 30 winemakers were obtained from participants at an AWRI Advanced Wine Assessment Course held in October 2005. Ten of the wines from the consumer study, not including wines CS1 and SH2, were presented to the group of experienced wine industry personnel. The group included mostly winemakers but also some wine educators, members of the wine trade and sommeliers. The wines were presented blind, in a randomised presentation order and the wines were presented by grape variety, with the judges being advised of the grape variety. Data from this tasting are shown in Figure 8.

Comparing the results in Figure 8 to that obtained from the consumers shown in Figure 4, indicates a very different pattern. The most highly regarded wines from the

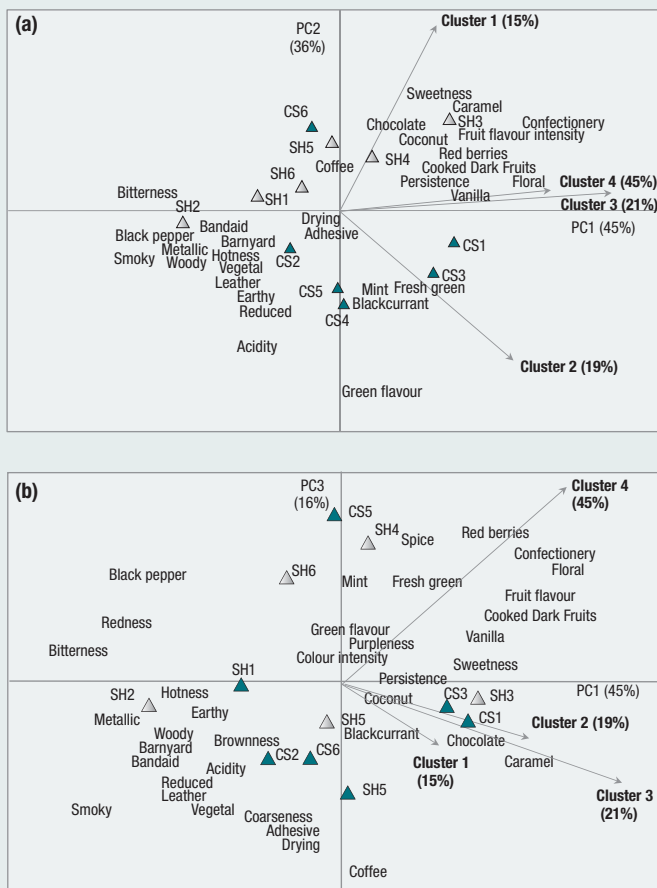


Figure 6. Internal preference map for the consumer cluster liking scores for the 12 red wines. The sensory attributes in italics are supplementary variables. (a) PC (Principal component) 1 vs PC2 and (b) PC1 vs PC3.

TABLE 2. PERCENTAGE OF CONSUMERS IN EACH OF THE FOUR CLUSTER GROUPS BY AGE AND BY DURATION OF WINE DRINKING EXPERIENCE.

	Cluster 1 (n=30)	Cluster 2 (n=38)	Cluster 3 (n=44)	Cluster 4 (n=90)	Total* (n=200)
Age (years)					
18-25	30%	24%	24%	21%	48
26-35	20%	37%	19%	21%	47
36-45	10%	11%	17%	14%	26
46-55	23%	15%	26%	22%	44
56-65	17%	13%	14%	21%	35
How long have you been drinking any type of wine?					
< 1 year	0	5%	0	0	2
1-5 years	27%	24%	14%	15%	37
5-10 years	23%	21%	26%	10%	35
10-20 years	7%	18%	24%	26%	41
> 20 years	43%	32%	36%	49%	85

*Row totals of numbers of consumers, note not including three outlier consumers as discussed in the text.

winemakers were CS₄, SH₆, SH₅, SH₄ and CS₅. The most liked wines from the consumers, SH₃ and CS₃ were not scored highly for quality by the winemakers. The wine SH₁ was scored lowest in quality by the winemakers and this was least liked by the consumers, but otherwise there was little agreement between the two sets of assessors. There was no significant correlation between the two sets of scores ($r=0.21$), confirming that the two groups have different responses to these wines. There was also no relationship among any of the consumer cluster mean liking scores and the data from the winemakers. The size of the standard deviations for the different wines indicates that for some wines there was good agreement among the judges (e.g. CS₃ and SH₆) while for others there was a wide range of quality responses, such as for SH₁.

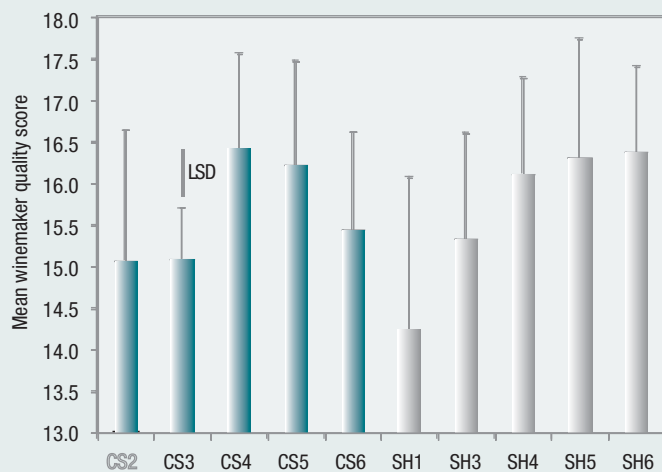


Figure 8. Mean quality scores for the 30 winemakers for the ten red wines. LSD: Least Significant Difference ($P=0.05$). The error bars are one standard deviation.

The observation that consumers and winemakers have different concepts of quality is not surprising, and does not, of course, mean that winemaker perceptions are not of value. It should be expected that winemakers, with years of experience carefully tasting wines on a professional basis, will look for different attributes in wines, and importantly be able to describe and categorise the attributes, compared to untrained consumers. As discussed above, consumer data allow a wine company to make judgements and decisions regarding wine styles that consumers or groups of consumers value, while winemaker assessments allow guidance for other purposes.

CONCLUSION

Consumer testing using a large, carefully selected group of untrained consumers assessing wines under controlled conditions, together with data obtained by a separate trained panel on the intensity of defined sensory attributes, provides a very rich source of information that can be used for a range of purposes. Wine companies can take this information and be confident that decisions in production will improve wine quality as perceived by the consumer. For example, the evidence from this study is that the least liked wines, (wines SH₁, SH₂ and CS₂), were higher in attributes *bitterness, pepper* (for wine SH₂), *smoky, bandaid, barnyard, vegetal, earthy, metallic* and *hotness*. Winemaking teams can use this information to ensure that brands destined for wide appeal are produced using grapes from vineyards selected with low pepper and vegetal flavour, or viticultural methods adjusted to minimise this character in sites that might have a propensity to produce wines with this attribute. Effort in avoiding ‘Brett’ aroma and flavour in the winery, together with care in minimising any bitterness, would also be likely to be rewarded in

increased consumer acceptance. Enhancing aromas and flavours in viticulture and winemaking that could be classed as 'sweet' would also be beneficial. Such attributes as *floral, confectionary, caramel, vanilla, coconut, red berries, overall intensity of fruit flavour*, and *dark fruits* were features of the most liked wines.

The role of the level of sweetness in a red wine should be studied further as only one wine with some residual sugar was included, and this wine also had high levels of 'sweet' aromas and flavours. The importance of balance in sensory properties should not be underestimated. There will always be a limit to the extent that a desirable attribute remains desirable, for example, a wine with a simple, strong, dominating floral flavour is unlikely to be strongly liked. For most attributes, an increasing amount of a sensory attribute is very likely desirable only up to a certain point. However, above this level liking would decrease similar to the behaviour that was observed for the relationship of Cluster 4 preferences and astringency. That such behaviour was not observed for most attributes in this study simply indicates that we had selected wines with few extreme sensory properties.

It should be noted that this study, while intended to encompass most major wine styles produced in Australia from Cabernet Sauvignon and Shiraz, was not exhaustive, and 12 wines cannot be expected to represent the entire population of wines commercially available. Wine companies wishing to pursue this approach would be wise to design a study with wines selected to answer specific business-related questions of importance to a narrower product category.

To address the question of the interaction of sensory and non-sensory influences on consumer perceptions of quality, there has been some research reported which assessed the effect of knowledge of the wine label and bottle on consumer preference compared to preference under blind conditions; that is, as assessed solely by sensory attributes (Yegge and Noble 2001). The study by Yegge and Noble (2001), on inexpensive Chardonnay wine, indicated that generally there was no influence of the label on the degree of acceptance or purchase intent, but for some wines an effect was observed. In contrast, a study on Champagne wine (Lange *et al.* 2002) showed that there was no difference in preference among the Champagnes under the blind condition, but substantial differences with the informed condition (price and label information made available to the consumers). These two studies suggest that for a 'prestige' purchase image and reputation is of importance, while for more common wines sensory properties are of greatest influence. Future Australian studies incorporating both sensory and non-sensory variables are planned, in part through a collaborative project between the University of South Australia and the AWRI.

The current challenges facing the Australian and world-wide wine industries, caused through global oversupply and increased competition, require that we should continue to apply successful outcomes arising from our range of research efforts in grapegrowing and winemaking practices. This application of our technical knowledge and skills in wine

production should be very closely coupled with knowledge arising from consumer preference studies. Defining and thus controlling wine quality to ensure we consistently meet ever-changing consumer requirements, whether in the Australian market, in existing overseas markets or in emerging markets, will undoubtedly be of great importance to the continued future success of the Australian wine industry.

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