Winemaking techniques that influence the quality of Cabernet Sauvignon wines

During the production of Cabernet Sauvignon wines a number of techniques can be utilised to enhance wine characteristics and quality. Some techniques are known to enhance the chemical and sensory properties of the ultimate wine. While many winemaking techniques are available, a number that have been noted for their contribution to Cabernet wine production are highlighted.

Characteristics of WA Cabernet Sauvignon Wines


The aromas and flavours of Cabernet Sauvignon wines are often noted by their distinction between the ‘fruity’ and ‘herbaceous’ / ‘vegetative’ characters in wine (Robinson et al. 2011a). Investigation of Cabernet Sauvignon wines produced in Australia found that wines with high ‘fruit’ related characters were separated from those with high ‘canned vegetable’, ‘earthy’ and ‘smoky’ characters, and those with ‘oak’ characters separated from those with ‘bell pepper’ and ‘canned vegetable’ characters (Robinson et al. 2011a).

Key wine characters

The characteristics of Cabernet Sauvignon wines produced from WA have been elucidated in clone selection and evaluation studies. Three years of wine sensory studies on four Cabernet Sauvignon clones selected in WA, known as the ‘Houghton’ clones, found the colour, aroma, flavour, tannin, body and overall wine character to vary depending on the clone and year of wine production (Ward et al. 2013).

Some clones, such as Houghton Clone 5, were found to have very high commercial potential producing ‘complex’ wines with ‘persistent, bright fruit flavours with cassis, blackberry, plum, current, cherry and savoury characters’ (Ward et al. 2013). Other clones, such as Houghton Clone 9, were shown to have very high commercial potential, producing aromatic wines with ‘delicate fruit flavours with blackberry, cassis, plum dominant, raspberry, olive, spice and savoury’ (Ward et al. 2013). Other clone selections contained ‘blackberry’, ‘cassis’ and ‘raspberry’ characters in addition to ‘plum pudding’ (Clone 20) and ‘herbal’ (Clone 19) aromas and flavours (Ward et al. 2013).

‘Consumers prefer wines low in bitterness, hotness and smoky characters with red berry, floral, caramel and vanilla aromas.’
Consumer and winemaker studies of Cabernet Sauvignon wines have revealed the characteristics that both segments prefer. Interestingly, evaluation of Australian Cabernet Sauvignon wines by 67 winemakers and 203 wine consumers, revealed winemakers’ quality concepts not to align with those of consumers. Consumers preferred Cabernet Sauvignon wines with low levels of ‘bitterness’, alcohol-related ‘hotness’, ‘metallic’, ‘smoky’ and ‘pepper’ characters (Lattey et al. 2010).

Consumers’ preference for Cabernet Sauvignon wines was segmented into clusters that were distinguished by wine aroma, ‘acidity’, ‘green’ flavour and astringency (Lattey et al. 2010). Both consumers and winemakers gave low ratings to wines with flavour related to Brettanomyces spoilage (Lattey et al. 2010). It is thought that knowledge of wine preferences could lead to analysis of these characters in wine and investigation to manipulate grape production processes in the vineyard to produce desired characters (Forde et al. 2011).

**Cabernet wine characteristic opportunities**

- Produce wines that concentrate on consumer preferences that meet the targeted market segment
- Gain a greater understanding of consumer perception and response to green characters in wine in the market place.

**Yeast selection**

In the production of wine, many yeast-derived constituents such as phenols, esters, acids, alcohols, carbonyl compounds and monoterpenoids all contribute to the complexity of aroma and flavour (Swiegers et al. 2008). Numerous commercial and naturally occurring yeasts are available for the fermentation of red wine that can impart distinctive sensory properties on the final product. Approximately 16 yeast genera are associated with wine fermentation, with variability in the natural occurrence and alcohol sensitivity of each yeast (Swiegers et al. 2008). Regardless of yeast selection, fermentation will often have the presence of the Saccharomyces yeast strain, especially in later fermentation stages, due to its tolerance to alcohol (Bisson 2004).

**WA studies showed vineyard site and canopy management to be of more influence than yeast selection.**

There have been limited investigations of yeast effects on the production of Cabernet Sauvignon wines in Western Australia. Cabernet Sauvignon wines made from grapes grown in WA (Gingin) were inoculated with different yeasts. Surprisingly, results showed that there was little effect in the volatile composition and sensory impact on wines fermented with EC 1118, Enoferm QA23 and Actiflore Cerevisiae yeasts (Robinson et al. 2011b). Instead, it was discovered that the vineyard site and canopy management were of more influence than yeast selection.

**Australian studies show wine style to be influenced by yeast selection.**
Other studies have found that the wine style can be notably influenced by the selection of yeast. The fermentation duration, alcohol concentration and chemical composition of wines can be altered depending on the yeast used during fermentation. Eleven yeasts were used in one study including seven *Saccharomyces cerevisiae* strains, two *Saccharomyces bayanus* strains and two *Saccharomyces hybrids* (Rojas et al. 2012). Most yeasts completed fermentation in 19 days however *S. bayanus* (AWRI 1375) took 26 days and one *S. cerevisiae* strain (AWRI 1554) took 32 days (Rojas et al. 2012). Distinctive wines were produced by *S. hybrid* AWRI 1501, *S. cerevisiae* AWRI 1554 and AWRI 1493 and the two *S. bayanus* yeasts strains, with the latter also having the ability to metabolise malic acid (Rojas et al. 2012).

Some yeasts have shown to influence the ‘green’ related aroma and flavour characters in Cabernet Sauvignon wines. These green characters are predominately imparted to wine by the chemical group known as methoxypyrazines. In particular some yeasts have affected the concentration of 3-isopropyl-2-methoxypyrazine (IPMP) in wine.

Wine fermented by Lalvin BM45 increased IPMP concentration although no increase in IPMP concentration from juice to wine was determined in wines fermented with EC1118, Lalvin D21 and Lalvin D80 (Pickering et al. 2008). However a sensory effect was detected in wines produced from different yeasts. Cabernet Sauvignon musts fermented with Lalvin D21 produced wines with high ‘jammy’ and ‘red berry’ flavours, low in ‘green’ characters. This is converse to Lalvin D80 that produced wines high in ‘green pepper’ and ‘green vegetable’ aromas (Pickering et al. 2008).

Further work has investigated the effects of malolactic fermentation (MLF) on the chemical and sensory properties of Cabernet Sauvignon wines. It has been found that fruit related aromas and flavours of wine can be influenced by the choice of MLF culture. Researchers found ‘overall fruit’ flavour to be higher in wines fermented with MLF culture *O. oeni* strains R1106 and R1118 in wines from the Limestone Coast, whereas wines from the Clare Valley were higher in ‘overall fruit’ flavour when fermented with *O. oeni* strain R1106 (Costello et al. 2012).

**Yeast opportunities**

- To further investigate the potential of yeasts to produce optimal aroma, flavour and wine characters for Cabernet Sauvignon wine production in WA.

**Wine maceration techniques**

During winemaking, the contact of juice and wine with grape skins can be manipulated in order to influence the desired aroma and flavour compounds in wine. The contact and fermentation of grape juice with grape skins is conducted to increase the colour, aroma and flavour content of the final wines. This process is referred to as maceration and results in more phenolics (including anthocyanins), tannins, polysaccharides and flavan-3-ols that influence wine sensory properties (Joscelyne 2009).
Extended contact with grape skins can occur after the crushing of grapes prior to the beginning of alcohol fermentation, or after the completion of alcoholic fermentation prior to pressing off skins. In surveys of Australian winemakers, both pre-fermentation maceration and post-fermentation extended maceration have been utilised in the production of Cabernet Sauvignon wines (Joscelyne 2009).

Numerous maceration techniques have been developed and employed with a variety of outcomes. Maceration techniques can be employed pre-fermentation, post-fermentation, with grapes and musts at various temperatures (including freezing of grapes, cold processes and elevated temperatures), for various durations, with the addition of enzymes, and a number of varieties. The use of various techniques, such as pulsed electric fields, to extract berry attributes has been investigated. There is conjecture on the effectiveness of these techniques with research groups not agreeing on results (Cai et al. 2014). Many studies have demonstrated that the effect of maceration variables can be specific to grape cultivar. As such the Cabernet Sauvignon wine grape variety is found to be readily receptive to these specific fermentation treatments (Moreno-Pérez et al. 2013).

**The timing, duration and temperature of skin contact are influential during wine production.**

As the effects of maceration are various, knowledge of the physical and chemical maceration process can help a winemaker to achieve the desired wine to meet market requirements (Casassa and Harbertson 2011). The composition of Cabernet wines is impacted by the contact time with skins and temperature (Callejón et al. 2012). A minimum contact time is required to extract wine aroma and flavour precursors.

WA cold soak research showed its application to vary depending on the fruit’s region of origin.

In recent maceration experiments in Western Australia, the influence of climate and cold soak on the chemical and sensory properties of wine was investigated. Cabernet fruit sourced from a warm climate (Swan District) was compared to fruit from a cool climate (Great Southern). All cold soak treatments were conducted at 4°C for five days prior to the commencement of fermentation. Results showed that wine quality was improved with the application of the cold soak to fruit from the Swan District. The wines made from the cold soak treatment had a greater depth in colour and hue as shown by the chemical and sensory analysis. These wines showed more palate weight, length and improved texture (Fennessy 2014).

The cold soak treatment received a higher quality score in comparison to the unsoaked (control) treatment with higher chocolate aromas and perceived fruit sweetness (Fennessy 2014). For Cabernet wines produced from the Great Southern, the influence of a pre-fermentation cold soak at 4°C for five days was minor. Wines made from the cold soak treatment were found to be higher in ‘dark berry’ aromas than the control although this was not significantly different (Fennessy 2014).

Research investigating the extraction of glycosides during grape fermentation found that pre-fermentation skin contact of a three day cold soak at 10°C increased total
glycosides by 103% while an ambient temperature (20°C) soak for three days increased total glycosides by 177% (McMahon et al. 1999). Cold soak maceration of grapes for six days at 20°C found at two days there was a 122% increase at four days there was a 201% increase and at six days there was a 270% increase in glycosides (Whitehouse). Extended maceration trials in California that kept the wine in contact with grape skins for 20 days after dryness showed an increase in both high and low molecular weight proanthocyanidins (Zimman et al. 2002). Overall colour results varied depending on vineyard site with extended maceration increasing colour in two Californian sites and decreasing colour in another two sites (Zimman et al. 2002). Longer macerations led to a decrease in colour and anthocyanins and an increase in proanthocyanidins, polysaccharides, astringency and bitterness (Gil et al. 2012).

Cold maceration of grapes at 10°C for seven days provided the highest level of anthocyanin extraction in comparison to freezing of grapes and must freezing with dry ice (Gil-Muñoz et al. 2009). Resveratrol was improved in Cabernet Sauvignon wine production by 27% by cold soaking (4°C for 24 hours) and 266% by thermovinification conducted after grape crushing at 65°C for 20 minutes (Clare et al. 2004).

**Must temperature during fermentation influences Cabernet wine quality.**

With anthocyanin extraction in wine, higher temperatures at 28 to 30°C resulted in a greater increase of anthocyanins in wine than temperatures below 20°C (He et al. 2012). The duration of extraction is also of effect, with the concentration of anthocyanins in the final wines reaching a maximum at five to six days skin contact time (He et al. 2012). Other authors have noted the levels of proanthocyanins (located in both skins and seeds) to readily increase in Cabernet undergoing pre-fermentation maceration at 25°C of up to 20 days (Busse-Valverde et al. 2012). This led to an increase in wine astringency and a decrease in bitterness.

The fermentation temperature of Cab Sauv was increased from 24°C to 32°C which resulted in an increase in high molecular weight proanthocyanidins. An increase in colour was also noted (Zimman et al 2002). Thermovinification effects on the resveratrol content of cab sauv wines – was shown to increase (Atanackovic et al. 2012). For Cabernet Sauvignon grape and wine production, passing the wine through a heat exchanger at the end of fermentation until the temperature reached 32°C resulted in an increase of proanthocyanidins of high molecular weight (Zimman et al. 2002).

The type of winery equipment employed during pre-fermentation cold maceration has also shown an influence on the chemical and sensory properties of Cabernet Sauvignon wine. The use of an automatic pumping-over tank was found to be more effective than that of an automatic punch-down tank and the wine aroma (Cai et al. 2014). The ‘fruity’, ‘caramel’ and ‘floral’ aromas were intensified and β-damascenone increased with cold maceration in the automatic pumping-over tank (Cai et al. 2014).
Wine maceration opportunities

- Further investigation of maceration techniques that enhance Cabernet wine production in key WA regions. This includes extended maceration timing and temperature.

Wine marketing

Understanding the key drivers of wine purchase decisions can aid the sale and advancement of Cabernet wines in WA. Numerous research and articles about the marketing of wine are available. Topics that are perpetually in the literature are those addressing wine price, reputation, brand, wine variety, wine awards/ratings and region (Lockshin and Corsi 2012). Indeed, many Western Australian Cabernets are marketed with these factors in mind.

Wine prices

Traditionally, wines categories are segmented by price and quality. That is, the price segmentation alludes to the quality. WA is known for the production of fine wines that meet the icon, ultra-premium and super-premium wine quality segments listed in Table 4 (WOWA). These segments refer to a domestic retail price that ranges from $15 to more than $30 per bottle with an export price range of $7.50 to more than $10 per litre.

Table 4 Wine quality segments, grape price, domestic and export wine price

<table>
<thead>
<tr>
<th>Wine quality segment</th>
<th>Grape price (A$/tonne)</th>
<th>Domestic retail price (A$/bottle)</th>
<th>Export FOB price (A$/litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icon and ultra-premium</td>
<td>&gt;2000</td>
<td>&gt;30</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Premium</td>
<td>601-1500</td>
<td>10-15</td>
<td>5.00-7.49</td>
</tr>
<tr>
<td>Popular-premium</td>
<td>301-600</td>
<td>7-10</td>
<td>2.50-4.99</td>
</tr>
<tr>
<td>Commercial</td>
<td>&lt;300</td>
<td>&lt;7</td>
<td>&lt;2.50</td>
</tr>
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Price is a major determinant in wine purchasing decision.

Studies of consumer purchase of Australian wines have shown price to be a major determinant in decisions. Consumers who do not have much involvement and experience with wine are known to purchase wine based on price more than consumers with high levels of involvement (Lockshin et al. 2006). Consumers with high involvement in wine place less regard on price than those with low involvement, who are also more likely to be attracted to price discounts (Hollebeek et al. 2007). However, wine lends itself to hedonic pricing where the characteristics of the product contribute to its price (Cardebat et al. 2004). Highly involved consumers are more likely to purchase wines based on the product’s intrinsic characteristics.
Reputation
The knowledge that a consumer may have about a wine, winery or brand can influence purchase decisions. Reputation is an important factor in the wine purchase. It has been found that wineries with a superior reputation for their wines can charge more for their products, and in most instances, they do (Ling et al. 2003).

Wineries with a superior reputation can charge more for their products.
A winery’s reputation is built on performance and consumers derive relative security in their purchase knowing that the winery’s products have performed well in the past. More so, winery reputation can be an important determinant of the price which has been evident in wine production (Cardebat et al. 2004). The investment in positive reputation building and maintenance over time by a winery can result in the production of a product that commands a higher price for all wines (Ling et al. 2003).

Wine awards
Wine awards, expert quality ratings and independent quality ratings contribute to the marketing and sale of wines. Wine awards can be easily recognised on wine bottles and, after price, are used to a greater degree by low involvement consumers than high involvement consumers (Lockshin et al. 2006). A wine receiving a gold medal has greater probability of purchase especially in the low and middle wine price points (Lockshin et al. 2006).

Wineries with a better reputation for their wine product can, and often do, charge more for their wines (Ling and Lockshin 2003). Studies have shown that favourable ratings from independent quality assessors can increase the price of wines. For instance, higher quality wines that have received quality ratings from Halliday could yield a return of between 9 and 14% for each quality point (Ling and Lockshin 2003). Robert Parker’s oenological grades have been shown to impact wine prices in Bordeaux (Ali et al. 2008) and a close relationship between wine price and independent quality ratings is found for Cabernet Sauvignon wines in California (Miller et al. 2011).

Wine region
In Australian wine production and marketing, the region of origin is a leading factor in consumers’ wine purchase decisions (McCutcheon et al. 2009). Predominately, regionality is thought to be derived from the reputation that a region has for the style of wines that it produces (Easingwood et al. 2011). However, it may also encompass other regional features such as varieties grown and climatic conditions.

Wine region is a leading factor in consumers wine purchase decision.
The key drivers of regionality in Australia are thought to be specialisation and having well-defined wine styles (Easingwood et al. 2011). However, regional characteristics extrinsic to wine, can also influence the consumer knowledge and desirability of a region. This may be related to key regional aspects, tourist attractions, festivals, accommodation, dining experiences and environment that can enhance regional knowledge and appeal.
Consumers have been found to be more likely to purchase wines from a region that they have visited (McCutcheon et al. 2009). This is further segmented by wine consumers who are highly interested / involved in wine and who have undertaken wine tourism activities. Consumers who have visited a particular wine region often remember the experience leading to an increased recollection of that region when making the wine purchase decision (Famularo et al. 2010). The consumer has an increased understanding of the wine origin that impacts positively on the purchase decision.

Wine regions that are well regarded for production of certain varieties may attract increased tourism interest and command a higher price for their product (Ling et al. 2003). Internationally, winery reputation is an important factor in the sales and price that a winery can obtain for its product (Cardebat et al. 2004). Research proves that prominent reputations for particular varieties lead to increased revenues (Ling et al. 2003).

The region of origin is also a consideration for wines purchased in overseas markets. In looking at back of label wine bottle information, consumers will consider the region of origin with the grape variety as a substitute for wine brands (Steiner 2004).

Furthermore, a renowned region can heighten the appeal of wine brands to consumers. This can been seen with small brands, rather than large brands, (Lockshin et al. 2006) that have a regional presence making them exclusive to consumers. Although consumer satisfaction with a wine brand is a strong determinant that they will be loyal and lead to repeat purchases (Bianchi et al. 2014). Wine knowledge and wine experience will also lead to increased repeat purchases.

**Winery size**

Interestingly, the size of a winery has implications for the amount of money that consumers would be willing to pay for the wine products. That is, smaller wineries are able to charge higher prices for their wines in comparison to wines of similar quality from larger wineries (Ling et al 2003). This may be due to the boutique nature of the winery, with the small winery being envisioned as more exclusive than the larger winery.

**Wine marketing opportunities**

- Investigate the consumer preference for Cabernet versus wine maker’s preference taking into account profitability, price point and affordability
- Case study of Cabernet wine price determination in WA. Investigate the price points of Cabernet in WA, market segments, how the price is set and how it can be raised
- Strategy for the long-term investment in wine quality and regional reputation leading to higher purchase prices across the product range.