Pre fermentation skin contact: how white wine composition and sensory characters are changed by leaving juice in contact with grape skins and seeds prior to fermentation

In 2016, the AWRI began conducting winemaking trials where a single batch of grapes is divided into smaller lots and one winemaking variable is changed in each fermentation. This produces a range of wines with differing sensory qualities, which are then presented at AWRI workshops staged across Australia. This article reviews pre-fermentation skin contact, a variable included in the 2019 Chardonnay winemaking trial.

Background

The amount of contact allowed between white juice, skins and seeds before fermentation has a marked effect on the composition and sensory characters of finished wine. For sparkling wines and Riesling, for instance, hand-harvested intact whole bunches coupled with modern winemaking equipment or traditional presses used in Champagne, can result in the virtual avoidance of skin contact. At the other end of the spectrum, 'amber' wines are essentially white wines made in the same way as red wines, with extended periods of both pre-and post-fermentation skin contact employed by some winemakers. While a large number of studies on pre-fermentation skin contact have been conducted, considerable variation in results for some parameters are reported. This can largely be attributed to differences in key variables such as the grape variety and the duration and temperature at which the skin contact is conducted (Ough and Crowell 1979, Darius-Martin et al. 2000).

Initial research was prompted by the introduction of mechanical harvesting

When hand-harvested fruit is delivered to wineries as whole bunches, the winemaker has a clear choice whether to press the whole bunches, crush the fruit and press as quickly as possible, or to crush and allow a period of skin contact before pressing. The introduction of mechanical harvesting represented a huge change in winemaking practice, with machine-harvested fruit undergoing skin contact during harvesting and transport to the winery. Prototype machine harvesters were developed in the USA in the in the late 1960s and were further developed and commercially introduced in Australia in the 1970s. This prompted the initial studies of pre-fermentation skin contact, which were focused on minimising any potential or perceived negative effect on wine quality from machine harvesting (Ough 1969; Ough et al. 1971; Ough and Berg 1971). These authors concluded that up to 12 hours of skin contact under conditions defined by their studies did not have a negative effect on wine quality; that is, no agitation, 70°F (21°C), 100 mg/L SO_2, and a rapid onset of fermentation.

However, a negative effect was observed after 12 hours when agitation occurred, as would happen when transporting machine harvested fruit. Those early potentially deleterious effects from machine-harvesting have been largely negated by subsequent technological developments including:

- machine harvesting at night in cooler temperatures
- the minimisation of material other than grapes (MOG) in the grape load
- the controlled dosing of SO_2 leading to its better dispersal throughout the harvested grapes
- more gentle grape handling from the harvesters themselves, through to destemmers, crushers and presses.

Pre-fermentation skin contact has potential benefits

Many studies have shown that skin contact increases wine aroma, flavour and perceived viscosity or 'body', which makes sense given that many of the related flavour and phenolic compounds are found in the grape skin. This particularly applies to esters, norisoprenoids, varietal thiols and terpenes, which are important for the varietal character of many wines. Tomašević et al. (2017) studied the impact of 15 hours of pre-fermentation skin contact at 15°C on a wide range of aroma and flavour compounds in the Croatian white grape variety Pošip. This study found that the concentration of most compounds increased, particularly the varietally important 1-hexanol, linalool, α-terpineol and β-damascenone, with the concentrations of the latter two more than doubling. A New Zealand study with Sauvignon Blanc also found that skin contact at cold temperatures led to large increases in several important varietal-linked aroma compounds (Olejar et al. 2015), and Arnold and Noble (1979) reported that in Chardonnay wines 'total aroma' and 'fruity aroma' increased with up to 16 hours of skin contact.

Ramey et al. (1986) examined the extraction of various groups of compounds from Chardonnay grape skins at a range of temperatures between 9.7°C and 28.6°C, at various time-points up to 30 hours of contact time. Strong positive correlations were seen in the extraction of flavonoids, total phenolics and important aroma compounds such as benzyl alcohol ('pleasant fruity') and 2-phenyl ethanol ('rose'), with increasing contact time and temperature, whereas negative correlations were seen for the alcohols 1-propanol, 2-phenyl ethanol and hexanol. The authors reported that the higher flavonoid concentrations produced by warmer skin contact temperatures resulted in lower quality and less age-worthy wines, and that flavonoid extraction was greatly reduced at temperatures around 10°C.

Differences in perceived wine viscosity resulting from pre-fermentation skin contact are widely attributed to both the greater extraction of phenolics from the grape skins and the sensory effect of higher pH. However, Gawel et al. (2014) reported that while pre-

fermentation maceration and hard pressing of skins both resulted in wines with higher phenolic concentrations, they had markedly different phenolic profiles. This included a higher concentration of flavanonols in the hard-pressing wines which consequently tended to be more bitter. The authors noted that the differences in phenolic extraction between the two techniques implied that mechanisms other than simple extraction were involved with pre-fermentation skin contact, and speculated that the greater length of contact time may have resulted in the enzymatic conversion of flavanols to flavanonols.

Other changes in juice and wine composition caused by pre-fermentation skin contact

In addition to increases in the concentrations of aroma and flavour compounds, and in phenolics associated with wine texture, other changes in must and wine composition are consistently seen. Ough (1969) was the first to report increases in pH, colour and nitrogen, and decreases in 'total' acid and tartaric acid in juices which had undergone skin contact. Test et al. (1986) reported similar changes in must pH, potassium, and total nitrogen (particularly ammonia), titratable acidity and tartaric acid in a study with Chardonnay. The decrease in tartaric acid was attributed to the precipitation of potassium bitartrate, which would also lead to an increase or a decrease in pH depending on the initial pH of the juice. In the resulting wines, both flavonoid and non-flavonoid phenolics and malic acid increased linearly during 6, 12 and 24 hours of skin contact. However, during sensory evaluation conducted by a trained panel when the wines were six months old, only small differences in wine flavour were detected, and only in the 12- and 24-hour treatments when compared to a non-skin-contact control. Small differences were also seen between 12- and 24-hour treatments, but not between the 6-hour treatment and the control.

Practical and logistical considerations

Skin contact may be conducted with or without the addition of pectinase and/or glucosidase enzymes, and it is recommended that it is performed under inert gas cover. Enclosed presses are ideal vessels for the procedure but may not be available for the length of time required at the height of vintage. If an enclosed press is not available, an important consideration is how to move the must to the press after a period of skin contact, without excessive aeration or additional mechanical maceration. Overhead tanks from which the must can be dropped directly into the press are the next best alternative to using enclosed presses.

Temperature has a major influence on the rate and nature of extraction, with higher temperatures resulting in wines with marked increases in phenolics, increased colour, a propensity to develop more quickly, and 'coarser' and more astringent mouth-feel (Ramey et al. 1986). However, concentrations of most volatile compounds do not appear to increase

at higher temperature, and therefore the best results are likely to be obtained between 10 and 15°C, which may require the must to be cooled between crushing and the skin contact holding tank. However, while cooler temperatures may be beneficial in optimising phenolic extraction, they could also result in a need to warm the juice prior to yeast inoculation using a heat exchanger, with a consequent increase in energy costs.

Pre-fermentation skin contact does present some risks

Pre-fermentation skin contact results in greater extraction of potassium from grape skins. This means that high pH post-skin contact is a potential risk if the initial pH of must is above approximately 3.56, because the precipitation of potassium bitartrate will cause the pH to further increase. That risk increases with increasing potassium concentration, and precipitation will be accelerated by cooler temperatures, a factor that should be considered if must is cooled to between 10 and 15°C or lower. Accurate measurement of pH, TA and potassium, and the addition of tartaric acid as necessary, is therefore advised if high pH wine is not desired. Measurement of potassium is especially important if the TA is high, because when coupled with a very high juice potassium concentration the relatively intractable problem of high pH/high TA wines can result. This was observed in some regions in 2018, and in cases investigated at the AWRI an average potassium concentration in juices of 1,800 mg/L was seen, compared to a mean concentration in Australian Chardonnay juices of 620 mg/L, with a range from 162 – 1,500 mg/L (Schmidt et al. 2010). In this situation the must should be adjusted to pH 3.4 regardless of the amount of tartaric acid required to do so, noting that a large amount of the acid will precipitate later as KHT, resulting in a decrease in the TA.

The presence of *Botrytis* when conducting pre-fermentation skin contact can lead to rapid oxidation due to the laccase enzyme, and it should be remembered that even in dry conditions, *Botrytis* may be present on the inside of tightly filled bunches. Close inspection is therefore recommended. It is also important that grapes are fully ripe, because skin contact coupled with subsequent pressing can lead to an increase in C6 compounds responsible for herbaceous characters in white wines (Ferreira et al. 1995). Ramey et al. (1986) also reported an increase in *cis*-3-hexen-1-ol (herbaceous, leafy), with increasing contact time and increasing temperature.

Other risks should also be considered. Several studies have concluded that wines made following skin contact are more susceptible to browning than non-skin-contact control wines (Singleton et al. 1980; Cheynier et al. 1989; Ramey et al. 1986), with the latter team reporting that contact temperatures above 15°C also increased protein concentrations and consequent bentonite requirements. Singleton et al. (1980) also found that increased skin contact duration increased the susceptibility of wines to pinking on exposure to oxygen, with Semillon the

most affected and Chardonnay the least affected of the four varieties studied. While every batch of grapes is different, a degree of standardisation of extraction can be achieved between batches and between vintages, by use of spectrophotometric measurements of phenolics.

In conclusion, pre-fermentation skin contact is a useful tool with which winemakers can influence the composition and sensory properties of wines, and its effects are well reported. However, it must be emphasised that the conditions under which skin contact is performed are critical to optimising the sensory and compositional changes, with the outcome potentially dramatically affected by factors such as grape variety, fruit quality, duration, temperature, initial pH, potassium and SO_2 concentrations, and grape and must handling techniques and equipment. The AWRI's 2019 Chardonnay trial included a 72-hour skin contact treatment, conducted at 5°C under inert gas cover with a 50 mg/L SO_2 addition, and without enzyme. The intense green colour of the grape skins which persisted throughout the 72-hour skin contact period was notable, and indicated high fruit quality, gentle grape handling and appropriate SO_2 concentration. The wine was consistently one of the most preferred during tasting sessions, displaying more fruit aroma and flavour, as well as a fuller mouth-feel, than the control wine. Analytically, the skin-contact wine had a slightly higher pH, alcohol and volatile acidity than the control wine, but because the wines were single replicates, care should be taken when interpreting these results.

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