ARC Training Centre for Innovative Wine Production

Technical note

STRATEGIES FOR DECREASING ALCOHOL LEVELS IN WINE

Introduction

The ARC TC-IWP has taken an integrated, ‘whole-of-production-chain’ approach to modulate alcohol levels in wines by developing new and/or evaluating existing viticultural and winemaking methods and techniques either before, during or after fermentation. The projects involved in the TC-IWP integrated strategy investigated: berry shrivel, early harvest and blending regimes, the use of *Saccharomyces* and non-*Saccharomyces* yeast strains, the individual or combined addition of commercial winemaking additives, and the effects of reverse osmosis/evaporative perstraction (RO/EP) treatment on wine composition and sensory properties. The following is a summary of those project areas:

VITICULTURAL PRACTICES

1. **Early harvest**
   Early harvest is the lowest impact approach that may produce wines with lower alcohol, but must be carefully considered to maximise grape flavour compounds that contribute stylistic domains to the final wine style. However, this approach may not be appropriate for all wine styles. Early harvest could be beneficial in time of rapid offset of berry shrivel, although options for colour enhancement in reds would need consideration depending on how early harvest is conducted.

2. **Minimising berry shrivelling**
   Any tendency to delay harvest to produce grapes with fuller and ‘riper’ flavours may result in significant proportions of shrivelled berries and wines with high alcohol levels. Berry shrivel is also accelerated with warmer temperatures and elevated evaporative

conditions during the ripening period [1-2]. Several factors, such as canopy temperature, irrigation, grape variety and rootstocks, under varying degrees of viticultural control, showed the potential to minimise this impact:

- ✓ Decreasing the temperature of the grape bunch microclimate may be achieved by site selection (aspect and exposure), canopy pruning regime (shading) and providing sufficient irrigation water for transpiration to cool the canopy via heat exchange.
- ✓ Maintaining plant hydration status. While long-term deficit irrigation has been shown to accelerate the rate of berry cell death, persistent maintenance of plant hydration status will lessen the extent to which cell vitality has declined at harvest.
- ✓ Grape variety is a genetic component of the propensity for cell vitality to decrease late in ripening. For example, some varieties have relatively high conductivity of the pedicel, which increases berry susceptibility to dehydration via negative hydrostatic pressure generated by the parent vine [1].
- ✓ Rootstocks with drought resistance characteristics may affect grapevine hydration status and decrease berry cell death.

WINEMAKING PRACTICES

1. **Water addition**

The recent change to regulations that permits addition of water prior to fermentation in order to dilute high sugar levels in must (to not less than 13.5° Baumé) (FSANZ 2017, A1119) opened many doors for deliberate manipulations of grape juice. We demonstrated that large decreases in final wine alcohol concentration may be achieved purely through this pre-fermentation approach. The addition of water to high sugar musts could be one of the most convenient ways to decrease wine alcohol content due to its ubiquitous availability and minimal impact on wine composition [3-6]. However, this approach tends to retain the compositional attributes of grapes at the time of harvest, and therefore, should be regarded as a useful last resort to limit the negative implications of a highly mature crop, rather than being broadly implemented after deliberately prolonging the maturation of grapes on the vine.

2. **Blending regime**

A blending practice of wines produced from different harvest dates ('double harvest' method) has been shown as an easy-to-adopt, flexible and low cost alternative to deal with increasing levels of alcohol without impairing wine quality. Descriptive sensory analysis performed on Verdelho, Petit Verdot and Shiraz blends showed that blends with significantly lower alcohol levels (- 3% abv) maintained sensory profiles similar to those of the wines made from the more mature fruit, while losing some intensity of less desirable green-like notes such as 'herbaceous' and 'grassy'. However, wines produced from early harvest grapes had higher levels of organic acids, particularly malic acid, which could be a problem for white wines, thus, it would be worth considering deacidifying the wines prior to blending [7-9].

3. **Reverse osmosis/evaporative perstraction (RO/EP)**

Removal of alcohol at a post-fermentation stage by a combined reverse osmosis-evaporative perstraction (RO-EP) is a widely used approach at the industrial scale.

However, a loss or reduction of volatiles during the dealcoholisation process is considered a major drawback of this technique. When the late harvest wines of Petit Verdot, Verdelho and Shiraz were dealcoholised by a RO-EP process, to yield wines at the same alcohol levels as an early harvest wine (up to -6% abv), significant effects were observed on some volatile compounds such as esters and higher alcohols, but not on monoterpenes and C_{13}-norisoprenoids, which are typically associated with varietal characters. Changes in the volatile composition of wines were reflected in the sensory properties of all wines, but it appears that Verdelho wines were the most affected. However, 13.5% abv Shiraz wines produced by selecting a specific harvest date, blending or dealcoholisation did not differ for any of the sensory attributes examined [7, 9]. Although similar trends were observed for different varieties, dealcoholisation appeared to be more suitable for red wines than for white wines. Nevertheless, prediction of the dealcoholisation effects on the sensory profile of wines remains challenging due to the complex matrix of the initial wine and the dealcoholisation operating conditions, i.e., the level of alcohol depletion required.

4. **Yeast selection**

The use of yeasts strains capable of yielding lower amounts of ethanol during fermentation is of high interest, as it is does not require any additional labour, equipment or handling. Commercial yeast stains, mainly *Saccharomyces*, are relatively predicable in the amount of alcohol they yield, thus recent research focused on selection, characterisation and improvement of non-*Saccharomyces* yeasts for lowering ethanol in wines, whilst enhancing the sensory properties. The following outcomes were highlighted:

- ✓ Commercially-available (thus readily-implementable) non-*Saccharomyces* yeast treatments were able to increase the intensity of descriptors generally regarded as more appealing in earlier harvest wines. As such, non-*Saccharomyces* yeasts appear to be a useful tool for optimising the quality of wines made from earlier harvests [10].
- ✓ An indigenous *Metschnikowia pulcherrima* isolate was selected based on its ability to lower wine ethanol content in sequential fermentations with *Saccharomyces cerevisiae* and characterised across a range of conditions. Depending on the inoculation regime (i.e. the delay in sequential inoculation varying between 3 days and 50% sugar consumption by *M. pulcherrima*), decreases of alcohol in white wines ranged between 0.6 and 1.2% abv.
- ✓ Remarkable diversity of *Lachancea thermotolerans* isolates was observed at a genetic and a phenotypic level, as well as the potential of certain isolates to decrease ethanol and pH in wines [11].
- ✓ *Torulaspora delbrueckii* showed high potential for use in a high sugar environment, but its performance and contributions in mono and mixed cultures needs to be defined for a broad set of different varieties and conditions [12].

5. **Winemaking supplements addition**

Wine mouthfeel properties can be modulated by the addition of winemaking supplements, especially in the context of improving the quality of wines made from early harvest grapes. Fruit harvested early may contain considerably lower tannin and polysaccharide concentrations, thereby producing wines with lower astringency and viscosity. To address these deficiencies, maceration enzymes, oenotannins and mannoproteins (MP) can be added individually or in combination based on their composition and potential to modify wine mouthfeel properties. However, a survey of commercial oenotannin and mannoprotein products showed that there is a considerable variation amongst their compositions, which is likely to lead to different effects on wine composition and, by extension, mouthfeel characters. Some products showed good agreement between product composition and their designated material of origin, while others showed significant differences [13]. Further in the project, a number of tannin and MP products were selected and added in various supplementations to ferments, but none of them significantly affected either astringency or body across treatments. This inferred that 'body' perception is not a mere mouthfeel attribute, but a complex interaction of flavour, viscosity and other compounding factors. Therefore, increasing mannoprotein concentrations alone could not achieve similar effects [14]. It was also found that MP and seed tannin can form aggregates that are larger than particles present in either material and significantly larger particles were formed in 12% abv than in 15% abv model wine. This study implied that certain polysaccharides can aggregate with tannin particles which may have an effect on wine phenolic composition and stability. Nevertheless, to achieve desired outcomes it is recommended to conduct bench trials in order to make informed decisions regarding the use of supplements.

Recommendations

Many high alcohol wines are in need of some alcohol correction and winemakers currently spend a significant amount of time optimising the wine alcohol level. The following outcomes of TC-IWP research projects were highlighted:

- ✓ Strategic irrigation and shading can limit berry shrivel and yield loss.
- ✓ Early harvest dates and blending regimes can achieve wines with lower alcohol levels while maintaining desirable flavours.
- ✓ Blending mature fruit with extremely early-harvest low alcohol wine yielded good results, but was not deemed to be particularly practical, whereas blending with water affords a very promising way to manage wine alcohol concentrations. However, this practice is recommended more for mitigation of negative implications of a highly mature crop, rather than for deliberate delay of harvest in the (somewhat misguided) search for riper fruit flavours.
- ✓ Blending of high and low alcohol final wines is an easy, simple and cost effective method that allows endless opportunities to produce wines with desired alcohol level, balance and complexity.
- ✓ The use of dealcoholisation technologies, such as reverse osmosis-evaporative perstraction (RO-EP), is an effective practice for alcohol removal, but smaller wineries may struggle to benefit from it because of the running costs of the equipment.
- ✓ Certain commercial non-*Saccharomyces* co-inocula were found to increase the quality and appeal of wine made from the earlier harvested fruit and/or to decrease the alcohol level of wines made from the later harvested fruit. While this practice does not require additional labour, equipment or handling, the final product can be hard to predict at present.

- ✓ Winemaking additives such as oenological tannin and mannoproteins can be used to improve mouthfeel and consequently quality of lower alcohol wines, but greater understanding of their compositional consequences and interactions in the wine matrix are needed to guide optimal selection for a given grape or must composition.

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