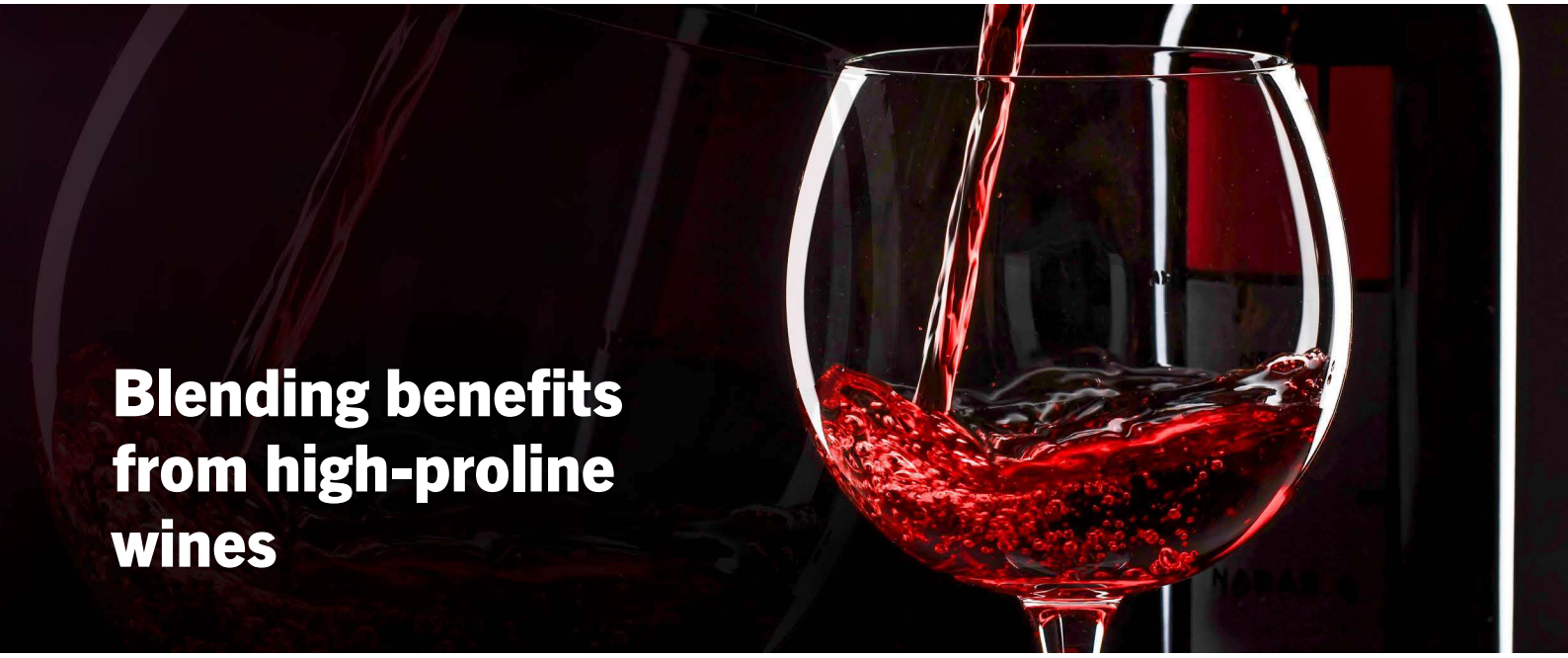

Blending benefits from high-proline wines

By Damian Espinase Nandorfy, Desireé Likos, Simone Lewin, Sheridan Barter, Stella Kassara, Shaoyang Wang, Allie Kulcsar, Patricia Williamson, Keren Bindon, Marlize Bekker, John Gledhill, Tracey Siebert, Robert A. Shellie, Russell Keast, Leigh Francis and Mark Krstic, Australian Wine Research Institute, PO Box 197, Glen Osmond, South Australia 5064

Mark Krstic

The amino acid proline has recently been shown to enhance viscosity, sweetness and flavour in red wines, while suppressing bitterness and astringency. This finding suggested that high-proline wines might be useful blending options to address flavour deficiencies in other wines. To test this a structured blending experiment was conducted with the blends assessed for chemical and sensory characteristics, as well as consumer acceptance. Results showed that blending with high-proline wine improved sensory qualities and increased consumer liking.

IN BRIEF

- Proline is an amino acid naturally found in grapes that has recently been shown to boost viscosity, sweetness and flavour of red wine.
- High-proline grapes are associated with warmer climates and riper grapes.
- A high-proline wine was tested as a blending option to improve a flavour-deficient wine and compared with a high tannin and colour wine as another blending option.
- Blends were assessed using sensory, chemical and consumer testing and statistical analysis conducted to identify significant associations.
- Blending with the high-proline wine had a strong positive effect on consumer liking that was stronger than the effect of adding a high colour, tannin and flavour blend component.

INTRODUCTION

Wine blending has been commonly practised throughout history. The goals of blending can include achieving targeted flavour properties, meeting regulatory requirements related to a region or style, increasing complexity, or correcting flavour deficiencies caused by vintage, vineyard, clonal and even barrel-to-barrel variation. The practice has been described as more of an art rather than a scientific undertaking (Beckett 2023) and very few scientific investigations of wine blending have been reported.

Recently, the amino acid L-proline has been shown to enhance viscosity, sweetness and flavour of red wine, while suppressing bitterness and astringency. The accumulation of proline in grapes is believed to be related to environmental factors such as water stress, with higher values reported in warmer climate wines (Huang and Ough 1991). As such, there are likely to be high-proline wines available in Australia's warm inland regions.

Bearing this knowledge in mind, an experiment was designed to assess the effects of blending a 'flavour deficient' Riverland Cabernet Sauvignon with different proportions of a high-proline Cabernet Sauvignon wine from the same region as well as a low-proline/high tannin/high colour alternative variety wine (Lagrein) from the Limestone Coast. Blended wines were assessed for chemical composition, sensory characteristics and consumer acceptance.

THE BLENDS

The three wines included in the experiment were all from the 2022 vintage and obtained from commercial wineries. The wines were produced using standard commercial practice, and went through malolactic fermentation. The two Cabernet Sauvignon wines had no oak treatment, while the Lagrein was sourced after two weeks in old oak barrels. The 'flavour-deficient' Cabernet Sauvignon was described as such by its producer.

Fourteen different blends were created (in duplicate) — namely, the three wines unblended, five blends featuring two of the wines and six blends featuring all three wines, with the proportions in the blend summarised in Table 1. The blends were bottled in random order into 375mL bottles under nitrogen gas cover and sealed with screw caps. Once bottled, the wine blends were stored in a temperature and humidity-controlled warehouse (17°C) for six months before sensory and chemical analysis. Following sensory assessment, the wines were shipped under controlled temperature conditions to a consumer testing facility.

SENSORY ANALYSIS, CHEMICAL ANALYSIS AND CONSUMER TESTING

Sensory analysis of the wines was conducted by the AWRI's specialised panel using the technique of quantitative descriptive analysis. The panel generated and then rated three appearance attributes, nine aroma attributes and 12 in-mouth attributes. The wines were analysed for a suite of volatile compounds associated with aromas and flavours in wine; for their tannin concentration and composition; and for amino acid concentrations. The physical viscosity of the wines was also tested.

Consumer testing was undertaken by 126 regular red wine consumers who attended two one-hour sessions on separate days. During the first session, participants completed an entrance survey and assessed seven randomly selected samples from the blends. Participants returned for the second session and were presented with the remaining seven random samples, after which they answered an exit survey describing their usage and attitudes towards wine products. During the sessions the consumers rated each wine blend for liking on a nine-point hedonic scale labelled 'dislike extremely' to 'like extremely' followed by a five-point purchase intention question labelled 'would definitely not purchase' to 'would definitely purchase' at a reasonable price.

Table 1. Component proportions of the wine blends.

Wine blend	Flavour-deficient Cabernet Sauvignon (%)	High-proline Cabernet Sauvignon (%)	Lagrein (%)
1	0	0	100
2	0	70	30
3	0	85	15
4	0	100	0
5	21.25	56.25	22.5
6	21.25	71.25	7.5
7	35	35	30
8	42.5	42.5	15
9	50	50	0
10	56.25	21.25	22.5
11	71.25	21.25	7.5
12	70	0	30
13	85	0	15
14	100	0	0

WHAT DID THE CONSUMERS THINK?

Very strong evidence was found supporting differences in liking across wine blends (Figure 1). The lowest liking score was for the wine comprised of 100% Lagrein (Blend 1, mean score 5.1), with the 100% 'flavour deficient' Cabernet Sauvignon wine (Blend 14) also not well accepted (mean score 5.5). An optimal set of well-liked blends included 2, 3, 4, 5, 6, 7, 8 and 11. Increasing the proportion of the high-proline Cabernet Sauvignon in the 'flavour deficient' wine resulted in progressively greater liking, indicating that the proline may have had an effect. Conversely, blending the Lagrein wine — selected as a high colour, flavour and tannin blending component — resulted in increased liking of up to 15% in the blend, but this wine was not well-liked individually or in high proportion in most blends. The most liked blend overall, Blend 3 (85% high-proline Cabernet and 15% Lagrein), had only a slightly higher liking score (mean score of 6.4) than the 100% high-proline Cabernet (Blend 4, mean score of 6.3). Of wines which contained a substantial proportion of 'flavour deficient' Cabernet, an optimum blend was able to be identified (Blend 11 – 71.3% flavour-deficient Cabernet, 21.3% high-proline Cabernet, 7.5% Lagrein; mean liking score = 6.2). This finding suggested a wine of comparable consumer acceptance could be strategically blended from mainly the 'flavour deficient' component — a wine with much lower production cost.

RELATING CONSUMER LIKING TO SENSORY AND CHEMICAL ANALYSIS

Statistical analysis was conducted to link the results from the chemical and sensory analysis with those from the consumer acceptance testing. Key results included:

- Increased liking scores were related to higher perceived viscosity, sweetness and berry flavours, connected to proline-rich wines with small proportions of Lagrein
- Blends highest in dark berries aroma and flavour were those with little or no 'flavour deficient' Cabernet Sauvignon in the blend, and an increasing proportion of Lagrein up to 15% (declining after that)
- Astringency and bitterness were associated with increased concentrations of polyphenolics and organic acids and lower liking scores. Vegetal and

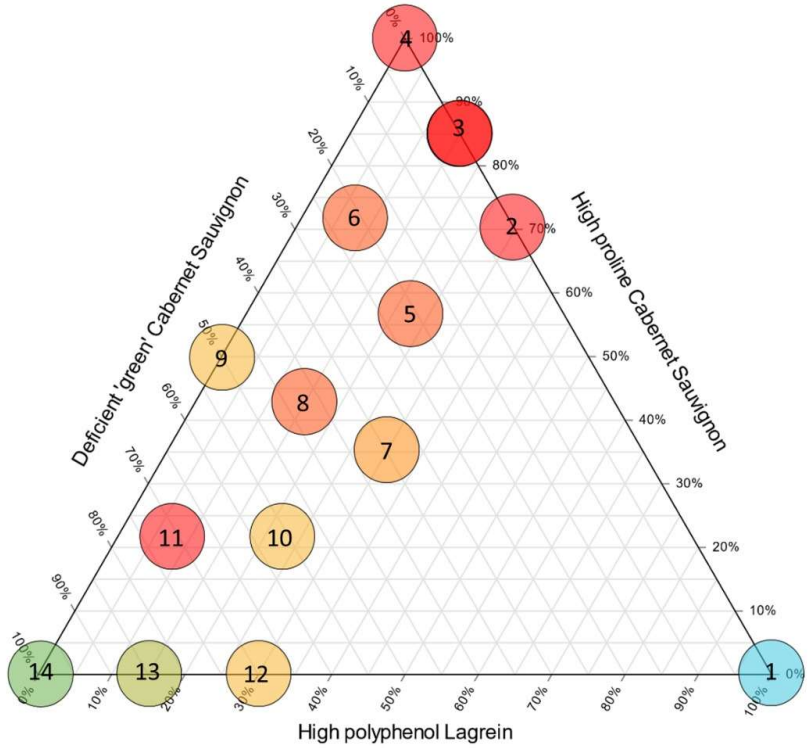

Figure 1. Blends produced from the three wines. Colours represent average consumer liking from blue (lowest) through green, yellow and orange to dark red (highest).

leather aromas in blends also reduced consumer acceptance and were related to the concentration of the thiols 3SH, 3SHA, PMT, 2FMT and MeSH, as well as guaiacol and isobutyl methoxypyrazine. Many of these attributes have previously been shown to be influential in consumer liking for red wines (Francis and Williamson 2015).

- Wines that were highest in astringency, sourness, bitterness, leather aroma, pungency aroma and vegetal aroma included Blend 1 (100 % Lagrein) and those with higher proportions of the Lagrein wine.
- Multiple blends successfully improved consumer acceptance of the 'flavour deficient' wine, particularly those with an increased proportion of the proline-rich wine.
- In agreement with the previous findings of Espinase Nandorfy *et al*. (2022), proline concentration in the wines was significantly and positively related to both sweetness and viscosity attributes and significantly negatively associated with astringency and bitterness attributes. Proline was also positively associated with dark berries aroma and flavour (two attributes most important in driving increased consumer liking and purchase intent).
- No significant differences in physical viscosity were observed between the blends, demonstrating that differences in perceived viscosity of wine are not explained by changes in measured physical viscosity when alcohol concentrations are equivalent.

CONCLUSIONS

This study demonstrated a more scientific approach to the traditional art of blending, using sensory properties, proline and polyphenolic concentrations to guide wine blending and improve wine flavour and consumer acceptability. It demonstrated that adding a wine with elevated proline to a blend could have a strong positive effect on consumer acceptance by enhancing sweetness and viscosity and diminishing undesirable bitterness and astringency. Interestingly, the effect of blending a high-proline wine on consumer acceptance was stronger than that of adding a high colour, tannin and flavour blend component, highlighting the potential for wine producers to target proline in grapes and wine as a non-carbohydrate sweetener, viscosity agent and flavour enhancer. Given that proline concentration in grapes is associated with warmer climates, producing high-proline red wines, or even extracts, to be used specifically as blending options to improve lower-flavour red wines or no and low alcohol products may be an option for producers in warm inland Australian regions.

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