Recent findings on rosé wine aromas. Part II: optimising winemaking techniques

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This article follows the publication of Recent findings on Rose wine aromas. Part I: identifying aromas studying the aromatic potential of grapes and juice, first published in The Australian & New Zealand Grapegrower & Winemaker Annual Technical Issue, 2005.

Introduction
The must of many “non-muscat” grape varieties, such as Merlot, Cabernet Sauvignon, Cabernet Franc, Syrah, Grenache, etc. is almost odourless, whether the grapes are pressed immediately, given pre-fermentation skin contact, or the juice is bled off from a vat used to make red wine. Their aromas develop during alcoholic fermentation. Our previous article (Part I) described how three of the main compounds involved in the fruity aromas of these wines were identified. 3-mercaptohexan-1-ol (3MH) and its acetate (3MHA) contribute to grapefruit, passion fruit, and boxwood nuances. Phenyl-ethyl acetate (PEA) is responsible for floral nuances. Finally, the role of isoamyl acetate (IA) in the amyl character of wines has been known for some time.

The research reported in our previous article demonstrated the existence of the cysteinylated precursor of 3MH (P-3MH) in must used to make rosé wines, as well as the correlation between the P-3MH content of the must and the quantity of 3MH released into the wine (Part I). Temperature and pre-fermentation skin-contact time also have an impact on the P-3MH concentration of the must. Extensive studies using Sauvignon Blanc have shown that the conversion of P-3MH into aroma is due to the metabolism of winemaking yeasts during alcoholic fermentation and is variable depending on the strain. A3MH is also formed by yeast via acetylation of 3MH. The impact of the yeast strain on the concentrations of fermentation esters (eg. PEA and IA) in wine has been known for many years.

Thus, the intensity and character of rosé wine aromas is very closely linked to the juice extraction and alcoholic fermentation methods used. In this article, we present various juice extraction methods, then study the factors that affect alcoholic fermentation. We then describe the impact of yeast strains and fermentation temperatures on rosé wine aromas. Finally, we discuss the ageing methods that best preserve rosé wine aromas.

Juice extraction methods
The methods used to obtain juice for making rosé wines varies considerably from one winemaking area to another.

Direct pressing
This is the most common method of making rosé wines. It consists of pressing red grapes immediately after picking, as is the case in making dry white wines. The pressing cycle must be adapted with long, slow pressing and a minimum of mechanical handling and crushing (number of times the press cake is broken up) to reduce the release of tannins. Direct pressing usually produces very pale-coloured juice. When grapes are hot (above 25°C) on arrival in the winery run the must through a heat-exchanger after crushing, or keep hand-picked grapes in a refrigerated room for half a day to reduce the temperature to around 15°C. If this is not possible, it is essential to press the grapes immediately. The juice must be cooled after pressing so that the must can settle.

Presses equipped with closed cages, cooling systems, or even nitrogen blankets may be used for pre-fermentation skin contact, to enhance the extraction of anthocyanins and aroma precursors. Contact time may be reduced by adding specific enzymes to the grapes. These preparations accelerate anthocyanin extraction and increase the yield of free-run juice by over 10%, compared with an untreated control in a press operated at reasonable pressures (see Figure 1). As is the case in white winemaking, the greatest attention must be paid to selecting the juice. When the grapes are simply left in the press for a few hours, up to 50-70% of the total volume of free-run juice may be obtained by gravity. Low pressures, 0.2-0.8bar, are sufficient to obtain the required amount.
Little is known about the impact of grape ripeness in different grape varieties on the organoleptic characteristics of wines made by bleeding the vats. For example, when some grape varieties are picked too early, the wine made from bled-off juice has unflattering, herbaceous nuances. Paradoxically, in other cases, juice from incompletely ripe grapes is the most aromatic.

Irrespective of the method used to obtain the juice, the greatest care must be taken to protect the must from oxidation (see Part I).

**Fermentability of musts intended for rosé wines**

Winemakers generally agree that rosé must is often difficult to ferment, independently of temperature, turbidity, or sugar content. Stuck fermentation is a frequent problem and the precise reasons for it have not yet been determined.

Among the factors that affect alcoholic fermentation kinetics, the role of available nitrogen used by yeast (ammonium cations + amino acids) has been clearly demonstrated. The available nitrogen content of ripe grapes varies from one grape variety to another, as well as according to the vine's nitrogen and water supply, the vintage, etc. The threshold for available nitrogen deficiency in must has been assessed at approximately 140mg/L. The available nitrogen content must be systematically adjusted when it is below 160mg/L. For reference, 20g/HL ammonium salts represent 42mg/L available nitrogen. We determined the available nitrogen content (Sörensen method or formol titration) of a large number of must samples from Bordeaux vineyards used to make rosé wines. As shown in Table 1, 68% of the rosé musts analysed had a nitrogen deficiency.

**Pre-fermentation skin contact**

When the grapes are healthy, pre-fermentation skin contact is quite common in making both dry white and rosé wines. This may be done directly in the press, as described above, or in a maceration tank, after destemming and crushing. Some vats are equipped with a membrane, drains, and cooling systems for optimum juice extraction. Between 500 and 600 litres of juice may be obtained per metric ton of grapes, depending on the variety. This juice is generally clearer (<300NTU) as it is filtered naturally by the pomace. When the pomace has been pressed, a variable amount of juice from the first pressings may be added to the free-run juice, depending on the overall yield and quality objectives.

Frequent pumping over under a nitrogen blanket is sometimes used to accelerate extraction of the colouring matter. Specific enzymes also improve juice yields and extract colour more rapidly. The rate of colour extraction is the main factor in determining contact time.

During this phase, P-3MH is extracted at the same time as anthocyanins. However, the vats with the deepest colour are not necessarily the most aromatic (see Part I).

**Bleeding**

In Bordeaux and other areas with a strong tradition of red winemaking, rosé wines are traditionally made by bleeding juice off from vats. The winemaker bleeds 10-30% of the free-run juice off 12-24 hours after the must has been put into the vat. Juice bled off from several vats is often gathered in a single vat and maintained at low temperature until the vat is full. This technique also increases the pomace/juice ratio in the vats used to make red wine.

![Fig. 1. Impact of adding enzymes addition on the free-run juice yield during pressing (grape variety: Cinsault, 2003, skin contact: 20 min in the press at 18°C). Source: Centre de Recherche et d’expérimentation sur le vin Rosé (rosé wine research center)].

Table 1. Available nitrogen content (mgN/L) of 150 musts used to make rosé wines (Bordeaux, 1998, 1999, 2001-2004 vintages).

<table>
<thead>
<tr>
<th>Minimum value</th>
<th>Maximum value</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>% nitrogen deficient must (N &lt; 140 mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>296</td>
<td>125</td>
<td>50</td>
<td>68</td>
</tr>
</tbody>
</table>

The role of lipids (unsaturated and saturated long-chain fatty acids) is very structure of membrane phospholipids was also clearly demonstrated. Associated with sterols, another survival factor, their special conformation regulates membrane fluidity, an essential parameter in sugar and amino acid transport protein function and, therefore, their assimilation by yeast. Yeast is only capable of synthesising these membrane compounds in the presence of molecular oxygen. It is, therefore, vital to aerate the must during the yeast multiplication phase, or during the first third of fermentation, before depletion of the first 50 grams of reducing sugars. Unless oxygen is added, the lipid content of the must is determined by the level of clarification (turbidity).
levels of rosé musts before fermentation have a major impact on their fermentability. Excessively clarified must has a very low lipid content and the end of fermentation is often very sluggish. It has recently been demonstrated that nitrogen-deficient musts may also have a lipid deficiency. In cases of nitrogen deficiency, excessive clarification, or anaerobic fermentation, it is, thus, essential to adjust the lipid content to ensure that the must ferments properly. Adding gross lees from juice with sufficient nitrogen (see Table 2) or using yeast activators with a high survival factor content (e.g., Dynastart®) provide effective solutions to this problem (see Figure 2).

Table 2. Improving the fermentation of a rose must with an available nitrogen deficiency by adding solids from a nitrogen-rich must (Cabernet Sauvignon, Bordeaux, 1999).

<table>
<thead>
<tr>
<th>Composition</th>
<th>Length of alcoholic fermentation</th>
<th>Reducing sugars (g/L)</th>
<th>Volatile acidity (g/L acetic acid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS wo N²</td>
<td>Stop</td>
<td>1.3</td>
<td>0.08</td>
</tr>
<tr>
<td>DS + N²</td>
<td>14 days</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1: Turbidity adjusted with gross lees from nitrogen-deficient juice, without adding ammonia nitrogen.
2: Turbidity adjusted with gross lees from nitrogen-deficient juice, adding ammonia nitrogen to obtain 200 mg/L available nitrogen.
3: Turbidity adjusted with gross lees issues from nitrogen-rich juice, adding ammonia nitrogen to obtain 200 mg/L available nitrogen.

Impact of yeast strain on rosé wine aromas

As described in Part I, the yeast strain has a major impact on the fruity aromas of rosé wines. Since 1998, we have tested a number of yeast strains in the Saccharomyces cerevisiae species, commonly used to make white and rosé wines as well as some experimental strains that are not yet commercially available, resulting from interspecific cross (S. cerevisiae/S. bayanus var. uvarum), strain A³¹²³ or intraspecific cross (S. cerevisiae x S. cerevisiae), strains X5 and B (A and B are experimental strains, not yet commercialised). At mid-fermentation, the analysis of the karyotypes of the total biomass for each yeast tested confirmed the implantation of all strains in the two experiments (data not shown). In those experiments, we used at mid fermentation for each tested yeast, the analysis of the karyotypes of the total biomass to confirm the implantation of strains.

The results in Table 3 clearly demonstrate the role of the yeast strain in releasing 3MH and producing APE: strain A generated the largest quantity of both compounds. The impact of the yeast strain on A³MH formation was not statistically significant. However, strains A, VL3c, and VL1 apparently formed more of this compound than strain 522d. These results indicate that the...
choice of a suitable yeast strain is a significant factor in making fruity rosé wine.

Breeding is a selection method used to cross yeast strains chosen for their winemaking qualities: capacity to ferment under difficult conditions, capacity to release the aromas of certain grape varieties, etc. This technique represents a major technological progress in yeast selection. As an example, we show the results obtained with two strains produced by an intraspecific cross (see Table 4). Strain X5 showed a remarkable aptitude to release 3MH from its cysteinylated precursor and produce its acetate (3MHA). It also generated very small quantities of fermentation esters. On the contrary, strain B released less of the volatile thiols and produced more fermentation esters, particularly isoamyl acetate. It is, therefore, possible to adapt the choice of yeast strain to suit the desired aromatic profile.

**Table 3. Impact of the yeast strain on the 3MH, A3MH and APE content of rose wines (Bordeaux, 1998, mean of 5 trials).**

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Strain A</th>
<th>Strain VL3c</th>
<th>Strain VL1</th>
<th>Strain S22d</th>
</tr>
</thead>
<tbody>
<tr>
<td>3MH (ng/L) (grapefruit - passion fruit)</td>
<td>848 a</td>
<td>603 ab</td>
<td>583 ab</td>
<td>177 b</td>
</tr>
<tr>
<td>3MHA (ng/L) (passion fruit - boxwood)</td>
<td>7.6</td>
<td>8.5</td>
<td>9.2</td>
<td>1.6</td>
</tr>
<tr>
<td>PEA (mg/L) (floral)</td>
<td>1.93 a</td>
<td>0.6 b</td>
<td>0.62 b</td>
<td>0.46 b</td>
</tr>
</tbody>
</table>

A = interspecific hybrid Saccharomyces cerevisiae / Saccharomyces bayanus var. uvarum.

Values followed by the letters a,b are statistically different (Two-factor variance analysis without repetition, p < 0.01).

Impact of fermentation temperature on rosé wine aromas

Fermentations at low temperature enhanced the wine content of some volatile compounds produced by the yeast during the alcoholic fermentation (esters, acetates, medium-chain fatty acids)5,6,7,9,23,28. More recently, it has been demonstrated that a high fermentation temperature (18-20°C) is preferable to the revelation of volatile thiols from their odourless precursors in Sauvignon Blanc wines14. As some of those compounds are present in rosé wines, we studied the impact of fermentation temperature on the release of 3MH, 3MHA. Our research considered two fermentation temperatures: 13º and 20°C, and four yeast strains.

As shown in Figures 3a and 3b, a higher fermentation temperature produced wines with significantly higher concentrations of 3MH and 3MHA, as in the case of Sauvignon Blanc14. It is, therefore, possible to adapt fermentation temperature depending on the aromatic profile desired, to enhance varietal or fermentation aromas.

Impact of ageing on fine lees on the volatile thiol content of rosé wines.

Once we had determined the positive impact of certain factors during alcoholic fermentation on the quality of rosé wines, we...
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It is thus probable that this compound contributes to preserving rosé wine aromas as well.

**Conclusion**

Recent enthusiasm for rosé wines in international markets proves that it is by no means a secondary product. Winemakers should, therefore, make every effort to ensure that their rosé wines suit consumer tastes.

The research presented in both Part I and Part II highlight the need to follow certain rules in making this type of wine. Indeed, rosé winemaking requires certain specific techniques. More detailed knowledge of the key compounds in the fruity aroma of rosé wines and the quantities present have made it possible to optimise winemaking methods. We are continuing our research, particularly focusing on yeast strain selection and optimising the use of enzyme preparations, and our findings will be published at a later date.

**References**


