WINEMAKING UPDATE

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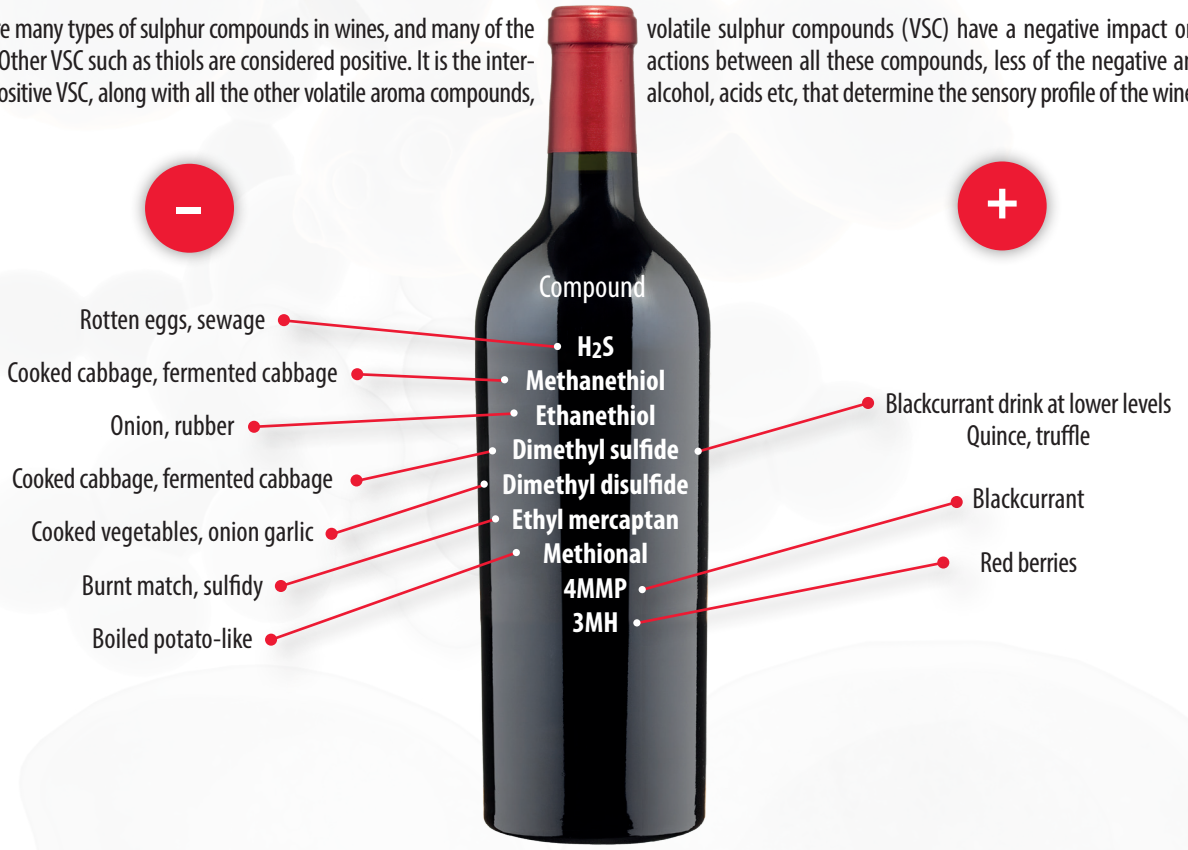
Highlight positive sulphur compounds while preventing the negative ones in red wine

There are many types of sulphur compounds in wines, and many of the volatile sulphur compounds (VSC) have a negative impact one wine aroma. Other VSC such as thiols are considered positive. It is the interactions between all these compounds, less of the negative and more of the positive VSC, along with all the other volatile aroma compounds, alcohol, acids etc, that determine the sensory profile of the wine.



The negative compounds can contribute to what we generally describe as reductive sensory notes and faults, and winemakers will try to control and minimise their production. The positive compounds can result in interesting fruity, varietal aromas and create an appealing sensory profile not only in white wines, but also in red wines. This Winemaking Update will focus on strategies to help reduce the negative VSC in red wines while also optimizing the positive ones through **appropriate yeast selection** and **specific nutrition management**.

Sulphur compounds: origin and factors influencing their production

"Reductive" off-flavors can lead to a qualitative depreciation of the wines as well as economic consequences (corrective actions, analysis costs, brand image, etc.). These negative VSC are mainly due to the development of H_2S and methanethiol (MeSH). Dimethyl sulphide (DMS) is also frequently included within this group but can also impact positively at lower concentrations.

The development of the typical H_2S and MeSH aromas mainly appear during the alcoholic fermentation (AF). H_2S can be directly formed by the yeast *Saccharomyces cerevisiae* from sulphur, sulphates (SO_4^{2-}) or sulphide (S^{2-}). Its production is strongly linked with the genetic background of wine yeast and to physiological and environmental factors. Yeast nutrition is a key environmental factor. Indeed, in case of inappropriate or insufficient nutrition, *S. cerevisiae* can degrade sulphur amino acids (such as methionine or cysteine) resulting in the release of H_2S.

Sulphur dioxide (SO_2) also belongs to the sulphur compounds family. *Saccharomyces cerevisiae* wine yeast can also produce SO_2 (from 10 mg/L to more than 90 mg/L) as it is an intermediate metabolite in the sulphate assimilation pathway. At the highest concentration, SO_2 can have a negative sensorial impact, masking the fruitiness of the wines.

Other volatile sulphur compounds contribute to positive aromas: the varietal thiols. The main wine thiols are: 3-mercaptohexanol (3-MH), 3-mercaptohexyl acetate (3-MHA) and 4-mercapto-4-methylpentan-2-one (4-MMP). These are well studied in white wines, however their role in red wine is not so clear. M Rigau et al. (2014) showed that in Syrah or Grenache blended with Mourvèdre, Carignan and Cinsault from Languedoc-Roussillon, the 4-MMP was responsible for blackcurrant aromas (from 16.8 ng/L to 54.2 ng/L). 3-MH and 3-MHA, when present at high concentration (respectively 11,487 ng/L and 154 ng/L), play a role in enhancing red berry aromas. Siebet et al., 2019 at the AWRI assessed the contribution of these thiols on single-varietal Australian wines coming from 10 different grape varieties and several vintages; 3-MH was found in all the wines but at a lower concentration than often found in Sauvignon blanc.

Selected Wine Yeast to reduce negative VSC

The advancement in wine yeast selection and understanding their metabolic pathways have led to considerable advantages for winemakers to manage their fermentation for specific wine styles while respecting varietal and regional identities.

A collaborative study between Lallemand, Institut Coopératif du Vin (France) and INRAe (France) provided new insight into the regulation of sulphur metabolism in wine yeasts (Noble and al. 2015). This study provided an innovative selection method for yeast (Patent "Method of control on the production of sulfites, hydrogen sulfur and acetaldehyde by yeast"), which was used for the wine yeast LALVIN PERSY™, specifically for red wines production to enhance fruity aroma expression. As shown in Figure 1, LALVIN PERSY™ has very low production of the main negative VSC. In addition to reducing the production of negative VSC, such as H_2S and MeSH, LALVIN PERSY™ has been shown to express bright red fruit aromas, especially in typically reductive varietals such as Syrah.

Figure 1. Reduction (%) of negative VSC with LALVIN PERSY™ versus a control in Syrah (IFV Nimes 2019).

Sensory analysis also showed a significant impact in the decrease of "reduction" type off-flavors while enhancing fruity aromas (Figure 2).

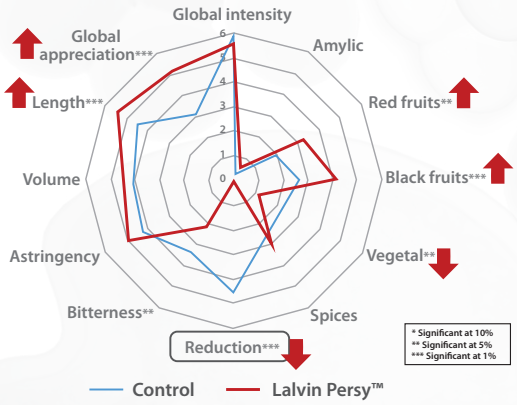


Figure 2. Sensory analysis of Syrah (IFV Nimes 2019) with a 15-judge panel comparing LALVIN PERSY™ to a control yeast.

Customized nutrition for Syrah and other reductive varietals

A well-balanced nutrition is key to assure the yeast viability and vitality (Tesnière and Blondin, 2014). If nitrogen is limiting, then vitamins, minerals and sterols will also be required. Pantothenate deficiency for instance, can lead to high H_2S production, even more with high Yeast Assimilable Nitrogen (YAN) levels (Wang and al., 2003). Recent studies (Duc and al., 2019) confirmed that pantothenate starvation triggers cell death in unbalanced nutritional conditions (Figure 3). The high pantothenate deficiency linked with high YAN led to a high cell mortality and resultant stuck fermentation (57.2 g/L of residual sugars), while the yeast cell viability is maintained when there is no nutrition imbalance.

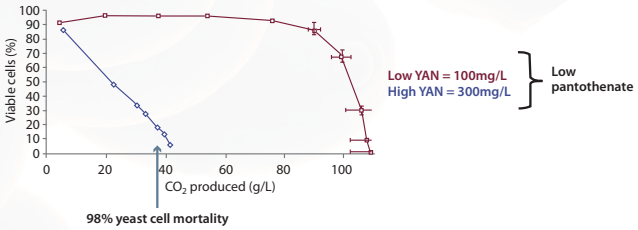


Figure 3. Viability of wine yeast with low pantothenate in the medium under high and low YAN conditions

Moreover, a well-balanced nutrition also plays a key role in the revelation of certain varietal aromas such as volatile thiols. Certain micronutrients (vitamins, sterols) can maximize the 3-MH release while an excess of ammonium (DAP) can limit the uptake of thiols precursors into the yeast cell (Subileau & Salmon, 2008). Also, in order to stimulate the *Saccharomyces cerevisiae* β-lyase activity, the enzyme responsible for thiol release, the best moment of specific nutrition addition is during the yeast multiplication (growth phase), when the enzymatic activity is the highest as well as the uptake of nitrogen sources and aroma precursors.

To reveal the varietal aromas while reducing the negative VSC, a specific yeast autolysate was developed. STIMULA SYRAH™ is rich in different nitrogen sources (free amino acids), specific vitamins (pantothenate, thiamine) and minerals to increase the release of varietal aromas and avoid sulphur off-flavors. In combination with a wine yeast such as LALVIN PERSY™, the impact on the VSC is even more significant. Figure 4 shows the impact of using STIMULA SYRAH™ with Lalvin Persy™ in a Syrah. The must was poor in thiol precursors, however, the combination of LALVIN PERSY™ and STIMULA SYRAH™ managed to increase 3-MH by 40%, bringing the concentration of 3MH above the perception threshold of 60 ng/L. Another trial in Syrah was evaluated by a expert panel of 33 judges and the wines showed lower reduction, and more aromatic complexity and length with LALVIN PERSY™ and STIMULA SYRAH™ , even one year after bottling (Figure 5).

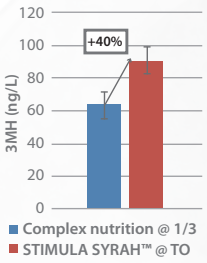


Figure 4. 3-MH production in Syrah (2019 INRAe, Pech Rouge) fermented with LALVIN PERSY™ with an addition of the nutrition STIMULA SYRAH™ compared to a control.

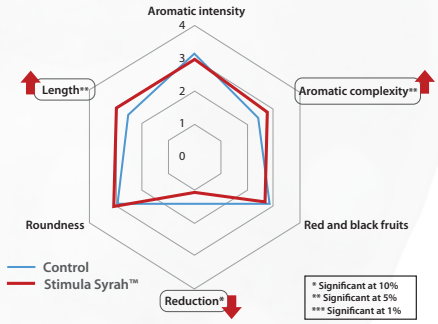


Figure 5 – Sensory evaluation 1 year after bottling of Syrah (2019 IFV Nîmes) fermented with LALVIN PERSY™ and STIMULA SYRAH™ compared to a control

Conclusion

The combination of LALVIN PERSY™ and STIMULA SYRAH™ is a successful way to minimize the production of negative VSC while maximizing the positive thiols in red wines such as Syrah. A carefully chosen selected wine yeast, along with its adapted and researched nutrition is a winning strategy for quality wines.