

The Wine EXPERT

Practical Winemaking Information

LALLEMAND

LALLEMAND OENOLOGY

STUCK FERMENTATIONS – CAUSES AND CURES

What is a stuck fermentation?

A stuck fermentation is one in which fermentation has ceased prematurely or the rate of fermentation is considered too low for practical purposes, leaving a higher residual sugar content than desired in the wines at the end of the fermentation (Bisson, 1999; Henschke, 1997). Not only does it delay the completion of the AF, but it can also lead to off-aromas formation. A residual sugar concentration of less of 2 g/L is considered dry or completed by winemakers (Bisson, 1999).

What are the factors leading to a stuck fermentation?

Glucose/Fructose ratio:

Saccharomyces cerevisiae is a glucophilic yeast, preferring glucose to fructose. Some yeast are more fructophilic than others. During fermentation, glucose is consumed at a higher rate than fructose, and the proportion of fructose increases as fermentation progresses. This can lead to imbalances in the wines, and under the stressful conditions found at the end of fermentation, make it more difficult for wine yeast to utilize this non-preferred sugar.

Nitrogen deficiency:

Nitrogen is the most important yeast nutrient and has a significant impact on wine fermentation. It influences both fermentation kinetics and wine profile (Agenbach, 1977; Bezenger and Navarro, 1987). The minimum quantity of YAN in must is 150 to 200 mg/L and lower levels are considered as nitrogen deficient. When the must is deficient in nitrogen, it will limit the yeast growth and fermentation speed (Bely *et al.*, 1990). YAN content has the most influence on the fermentation speed; it impacts the yeast biomass at the beginning of fermentation, as well as the sugar transport kinetics during fermentation.

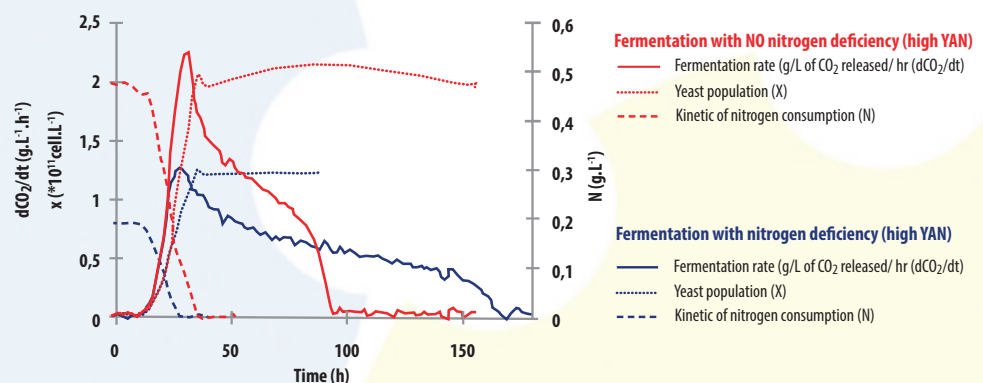


Figure 1. Nitrogen depletion during the yeast growth phase.
(Sablayrolles J.M., SITEVI conference 2015)

Lack of oxygen and the role of sterols:

Oxygen plays an essential role in alcoholic fermentation helping the development of an adequate yeast population and maintaining their vitality. Oxygen is required for the synthesis of survival factors such as sterols and unsaturated fatty acids (Kirsop, 1973; Kirsop, 1978; Alexandre *et al.*, 1994; Fornairon-Bonnefond *et al.*, 2002), which are components of the yeast cell membrane. They play a key role on the membrane structure helping to maintain the membrane fluidity, cell integrity and viability.

Improper yeast rehydration and handling:

Proper yeast rehydration is key in a successful alcoholic fermentation (AF) as it is a crucial phase for the survival and efficiency of the wine yeast. If the yeast is not properly rehydrated, more than half of the yeasts population can die. It is very important that manufacturer's instructions be followed particularly with respect to the dosage (Figure 2), the medium and temperature used for rehydration. During yeast rehydration, the active dry yeast will absorb water and recover their original form. The organs inside the cell continue rehydrating and a part of them disperse in the rehydration water. This loss can represent between 20-30 % of the dry weight of the yeast and can result in a micronutrient deficit.

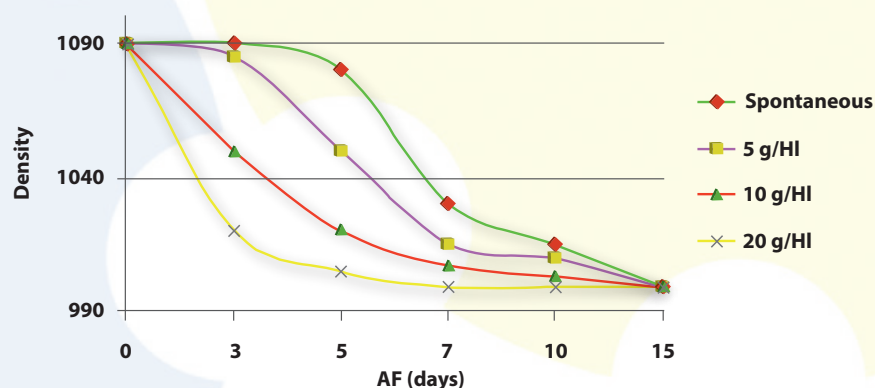


Figure 2. Impact of inoculation rate on AF.

Lack of temperature management:

Temperature will affect AF when it is the extreme, either too low or too high, since it has been shown that ethanol toxicity increases at extreme temperature. The yeast cell membrane is weakened and eventually it leads to cell death.

Inhibitory metabolites:

Grape must composition may have inhibiting toxic compounds that affect yeast viability and fermentative activity, and that are responsible for sluggish or stuck alcoholic fermentation. Inhibiting toxic compounds, such as short and medium chain fatty acids (SMCFA) have been widely described for their inhibition of alcoholic fermentation. Pesticide residues (fungicide, herbicide, insecticide) can also seriously affect yeast viability and compromise the end of fermentation. Recent studies also showed that they can negatively impact the production of aromas (namely esters) and the wines fruit character (Noguerol-Pato *et al.*, 2014).

Nutritional imbalance:

Nutritional imbalance is different than nitrogen deficiency, as having lower YAN levels is a factor that in itself, does not explain everything. Indeed, well-balance nutrition (including minerals, vitamins, sterols, organic nitrogen) is the optimal key to assure yeast viability as well as optimize the yeast aroma biosynthesis and release. New results (Blondin *et al.* 2016 in press) have shown that even if the YAN is high, starvation of oleic acid, ergosterol, and panthothenate as well nicotinic acid, will lead to loss in viability for the yeast and eventually death resulting in and stuck fermentation and overproduction of H₂S. When choosing a nutrient, quality is as important as quantity since only organic nutrients will provide those optimal growth factors as well as nitrogen and have a better nutritional balance than with only chemical DAP.

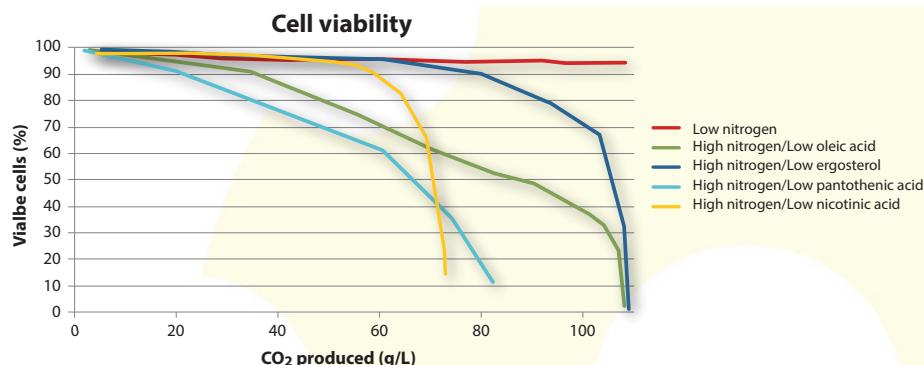


Figure 3. Impact of various vitamins and sterols (in high YAN conditions) on yeast viability during AF. Camille Duc, 2016, 12th Levures, Modèles et Outils Symposium.

Vitamins & Minerals:

Minerals serve as:

- Cofactors of several glycolytic enzymes.
- Increase ATPase activity and the pumping of the compounds across the yeast membrane.
- Increase yeast tolerance to ethanol and temperature.
- Antagonistic effect on the toxicity of heavy metals.
- Regulation of cellular growth
- Regulation of the formation of alcohol and esters.

Vitamins are organic compounds essential for the optimum growth of yeasts cells and for their capacity to survive under stressful conditions. The majority act as enzymatic cofactors. They can also intervene in energy transfers or in supporting membrane integrity.

THE RESULTS

HOW TO CURE A SLUGGISH OR STUCK FERMENTATION?

Yeast cells have the extraordinary capacity to adapt to different stress factors in a difficult environment of the grape must (high sugar, low pH, gradual ethanol increase, nutrient depletion, competition with other microorganisms, etc). However, the difficult conditions can prevail and the result is a fermentation that won't finish, and one must take necessary actions to cure a stuck fermentation: the density is not decreasing anymore, or very slowly, and some off-aromas might be creeping up.

Quick actions are necessary to avoid microbial spoilage, the apparition of wine faults (H₂S, Brett odors, VA, etc) and get the fermentation going again. A reliable protocol that can be applied quickly and efficiently can help handle the different causes of AF problems.

Cleaning the must:

Grape must may contain toxic compounds that inhibit fermentation such as short and medium chain fatty acids (SMCFA) and pesticides.. A new generation of yeast hull products with good absorption capacity and an affinity for these types of compounds are now available. Trials have shown that with those yeast hulls such as RESKUE™ favor

complete and steady fermentations thanks to the removal of SMCFA and pesticide residues (Figure 4).

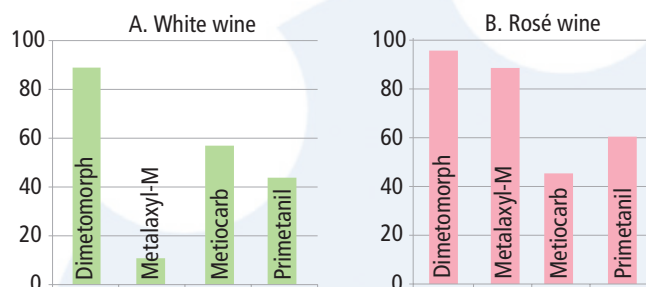


Figure 4. Lab-scale trials, White (A) and Rosé (B) wines contaminated with several pesticide residues, Spain, 2013. Pesticide removal (%) after addition of ResKue™ at 40 g/hL.

Using the right yeast

When fermentation stops mid-stream, the must generally contains much more fructose than glucose, the form of sugar that yeast prefer. To overcome this glucose/fructose imbalance, it is important to choose a yeast that has a strong affinity for fructose such as **Uvaferm 43™**, which

THE RESULTS (CONT'D)

is more capable of fermenting fructose and has a very high fermentation capacity and has a high alcohol tolerance. (please consult Wine Expert 2012 on *The fermentation of fructose in winemaking*).

Lallemand R&D with our premium knowledge of yeast growth and metabolism, developed a production process that makes the yeast cells more resistant to stress conditions caused by high alcohol content. Uvaferm 43™ was then optimized and pre-acclimated during multiplication with specific micronutrients and survival factor protection. This survival factors include specific sterols and polyunsaturated fatty acids that strengthen the yeast membrane. The yeast cells are then more robust, with a lower mortality rate after inoculation, and require less time to acclimate to the must. **This simplifies the process of restarting your fermentation with only a few steps with the new Uvaferm 43 Restart™.**

In trials done with Uvaferm 43 Restart™, it was shown that an average of one week was gained when restarting a stuck ferment as illustrated in Figure 5 in a Primitivo from Puglia in Italy.

The right nutrition

Right at the beginning of fermentation, vitamins, minerals and available nitrogen are consumed very quickly. This can cause sluggish and stuck fermentation as indicated above. It is then key to add nutrients naturally rich in these elements such as Fermaid O™ to feed the yeasts when restarting a stuck fermentation. Fermaid O™ or Nutrient Vit Nature™ (when added at 1/3 sugar depletion) supplies critical nutrients to help the yeast avoid stressed conditions. It is one of the best nutrients available for wine yeast as it only contains organic nitrogen and all the essential elements for the yeast to complete AF.

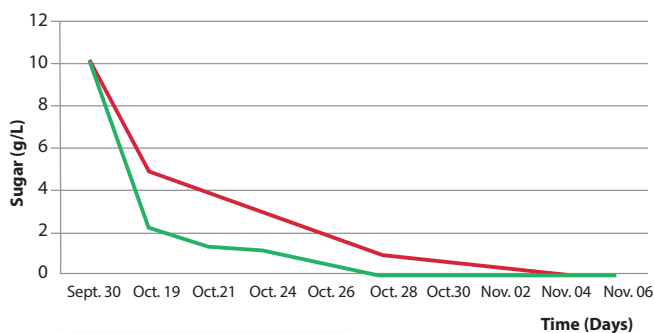


Figure 5. Sugar consumption with 2 yeasts to complete fermentation after restarting a stuck Primitivo wine from Italy.

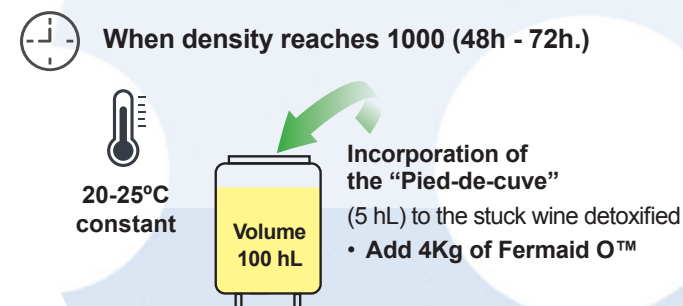
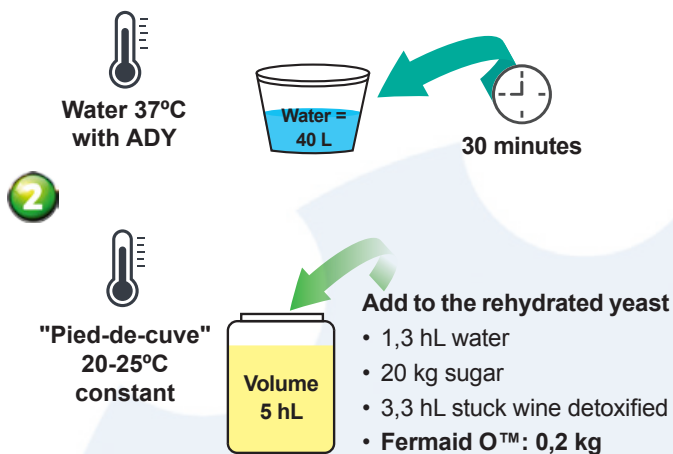
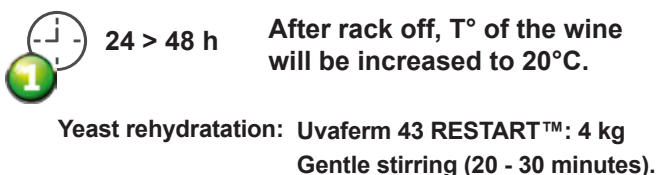
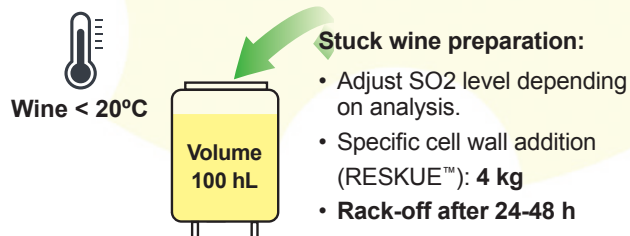
THE RIGHT PROTOCOL

When restarting a stuck fermentation, even with a clean must/wine, the proper yeast and equipped with the best nutrients, we now understand that using an efficient protocol will secure the process. With the help of the experts at Inter-Rhône (France), a protocol was validated to make it simple, fast and efficient.

NEW PROTOCOL

Validated by InterRhône (France)

Simply **RESTART** a stuck wine: Volume of wine = 100 hL



A WORD FROM OUR EXPERT

Patrick Vuchot



Patrick Vuchot is an engineer in agronomy and oenologist from Montpellier Supagro. He has a Ph.D. in Food Science, from his thesis on the subject of aging on lees in red wines and its impact on the polysaccharide content of wines.

In 2001, he started at Inter Rhône, in France as the manager of oenological experiments and in 2010 he became the head of the R&D

Department and Director of the Institute Rhodanien. His department has 4 poles. The first works on microbiology through the selection of microorganisms of interest and characterization, as well as understanding microorganisms of alteration. The others work on oxygen and packaging, winemaking technologies and ageing, as well as the health aspect of wine.

An OIV expert for the "Microbiology" group and the "Technology" group, as well as the Scientific and Technical Committee of the sector, he is a recognized expert in the wine industry.

For the last 30 years, the quality of the Rhône Valley wines is growing steadily and the yield have been considerably decreased. Coupled with global warming, and the inherent characteristics of the Grenache grape, the grape maturity is often harvested with high levels of alcohol, regularly exceeding 16% v/v.

Because of this problem and being able to manage alcoholic fermentation properly, Inter Rhône has selected a yeast for recovering difficult or stuck fermentations, the yeast Uvaferm 43™. This yeast, by its innovative fructophilic character has proven and is now hailed on the different markets as the best yeast to cure stuck fermentations.

However, the many steps necessary for acclimatization remained quite heavy to be implemented in the cellars. Lallemand has developed a new production process to impart improved strength and enable them to overcome some stages of acclimatization, allowing a simplified inoculation protocol.

Inter Rhône has validated the excellent performance of Uvaferm 43 Restart™ through many cellar trials. The yeast showed a good recovery capacity with the simplified protocol.

IN SUMMARY

Proper fermentation management begins right when the yeast to ferment the wine is chosen and how it will be prepared for the AF. A yeast adapted to must conditions and wine style development or to valorize the terroir is crucial. It must be re-hydrated properly with protector such as Go-Ferm Protect™ or Go-Ferm Protect Evolution™ to have its membrane in optimal shape in the difficult wine environment. It must be properly fed with the right nutrients such as Fermaid O™.

Sometimes, all the right preparations can't overcome extreme or unmanageable conditions. When an AF is sluggish or stuck, there are now means that are efficient and reliable to solve this issue. Proper must detoxification with the new Reskue™, as well as using the robust and pre-acclimatized Uvaferm 43 Restart™ in a easy to use protocol is a sure way to ensure wine quality.

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