wine ingredients News

Stuck and sluggish ferments, an efficient solution to restart.

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Stuck and sluggish fermentations are still a major concern, waste of time, and in the worst cases lead to irreversible wine spoilage. Problem fermentations are now better known, which make it possible to develop prevention tools, including selected yeast strains and winemaking practices such as the addition of nitrogen and oxygen during mid-fermentation (Sablayrolles and Al, 1996), or the use of complete activators based on inactivated yeast (Lebrun and Pellerin, Revue onologues).

Although problems are more likely to occur with high alcohol, ethanol is far from being the sole cause. The chances of not consuming sugars to dryness increase with high sugar content, low yeast available nitrogen, late fungicidal treatments, difficult to ferment varieties and a lack of control over the winemaking process. The combination of several of these factors will increase the probability of the occurrence of a problem.

The multiplicity of causes makes stuck and sluggish fermentations quite unpredictable and restart procedures are often not guaranteed and difficult. With Extraferm® yeast hulls used in combination with Fermichamp (selection n° 67J INRA Narbonne), DSM proposes an original curative solution.

Must detoxification with Extraferm® yeast hulls

During fermentation, wine yeast produce several auto-toxic compounds such as ethanol, carbon dioxide and medium length chain saturated fatty acids (C6, C8 and C10) which inhibit sugar transport (Larue *and Al*, 1982; Salmon *and Al*, 1993). The objective of must detoxification is to remove these compounds and create more favorable conditions for yeasts growth activity.

The use of a specific adsorbent property of yeast cellular envelopes, also known as "yeast hulls" or “yeast ghosts”, is authorized to restart fermentation as it removes inhibitors (Lafon-Lafourcade *and Al*, 1984). Yeast hulls are produced from the elimination of yeasts cytoplasmic contents by autolysis in controlled conditions, followed by centrifugation. Yeast hulls not only detoxify, but also provide nutrient and yeast "survival factors"such as fatty sterols and long chain unsaturated fatty acids. These compounds increase the restarting yeast strain viability at the end of fermentation.

HALO, an innovative process

Traditional yeast hulls can transmit a yeast odor to the wine, even when used at low dose rates (from 20 g/hl). Moreover, their effectiveness in detoxification is sometimes limited. DSM research developed an innovative production process, with the objective of obtaining highly adsorbent yeast hulls that would not transmit any odor to the treated wine even at high dose rates. The yeast hulls resulting from this innovative process are marketed under the brand Extraferm®. This new product was established according to the international oenological Codex method in DSM laboratory. A model decanoïc hydro-alcoholic solution, containing 3 mg/l of acid, was treated with increasing amounts (100 to 800 mg/l) of yeast hulls. The fatty acids were detected by NMR, after homogenization and 20 hours at ambient temperature. The analysis showed Extraferm® hulls had better adsorption capacity of toxic compounds (figure 1). In a model solution 40 g/hl of Extraferm® hulls eliminated 30 % of the decanoïc acid.

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Laboratory tests revealed more properties of interest in winemaking,

- Choline and glycéro-phosphoryl-choline release. These compounds play a role in fatty acids biosynthesis.
- Mannoproteins release (figure 2). Mannoproteins could partly compensate for mouthfeel loss caused by the unavoidable racking that takes place before fermentation restart.

Restarting stuck fermentations in production conditions

Production scale trials in France, Germany and Portugal confirmed the technical interest of DSM yeast hulls.

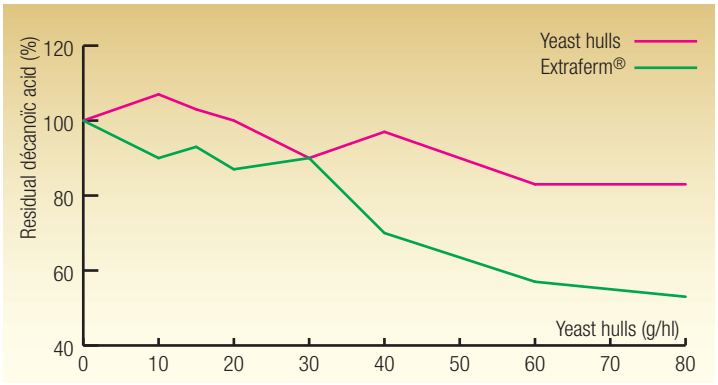

Figure 1: *Reduction in the decanoïc acid content in a model solution by addition of Extraferm® yeast hulls.*

Of all the restarting procedures tested, treatment with 30 g/hl of Extraferm® (figures 3 and 4) gave the best results, shorter re-fermentation duration (13 days) and lower residual sugars and volatile acidity.

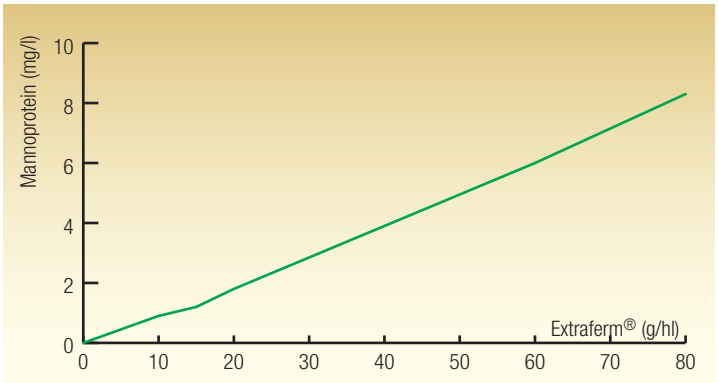

Figure 2 : *Mannoprotein release in a model solution treated with Extraferm® yeast hulls.*

The absence of yeast odor in treated stuck wines was confirmed. Wine characteristics were preserved for dose rates up to 100 g/hl (the legal maximum amount being fixed at 80 g/hl). Re-fermented stuck wines were submitted to sensory analysis to evaluate the "yeast odor" (0= “no perceived yeast odor", 5 = "very marked yeast odor"). The results (table 1) confirm the effectiveness of DSM innovating production process.

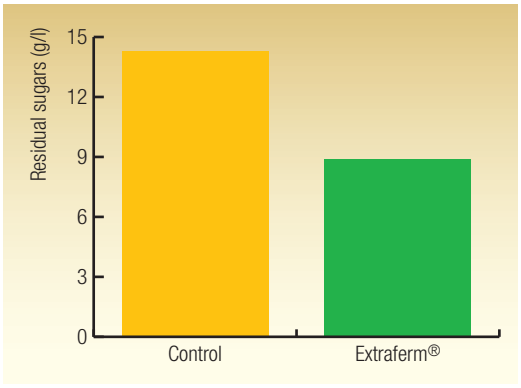

Figure 3: *Residual sugars after 13 days of restarting fermentation of a Sylvaner must.*

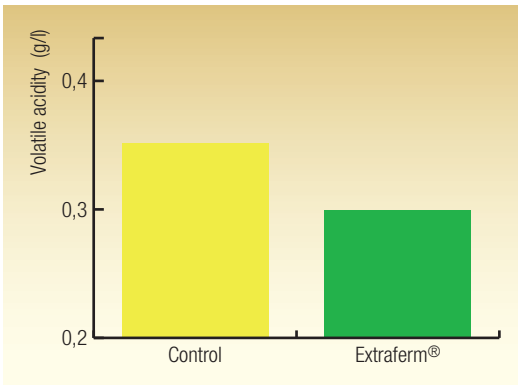

Figure 4: *Volatile acidity after 13 days of restarting fermentation of a Sylvaner must.*

Wine	Yeast hulls (g/hl)	Control	Traditional yeast	Extraferm®
wine A	30	0	1	0
wine B	30	0	5	2
wine C	100	0	5	0
wine D	100	0	5	1
wine E	100	0	4	0

Table 1: *Intensity of the yeast odor (measured from 0 to 5) in wines treated by various yeast hulls.*

Fermichamp®, a high alcohol tolerant fructophile yeast to restart fermentations

Even after adsorption of yeast inhibitors an arrested must remains hostile for yeast development as it contains high quantities of ethanol and very poor nitrogen and nutrients levels. Moreover, the fermentable sugar ratio is considerably modified by the first fermentation. Although grape musts are composed of glucose and fructose in equal quantities, glucose is fermented in a preferential way. The fructose/glucose ratio thus increases throughout fermentation. With most yeast strains, fructose accounts for 70 % of fermentable sugars at mid-fermentation and over 95 % when residual sugars are below 20 g/l. In light of the specific conditions of a stuck wine, the qualities of an adapted

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yeast to restart fermentations can be defined:
- high alcohol tolerance,
- low nitrogen requirements,
- ability to ferment fructose.

Comparison of the effectiveness of four yeast strains to restart stuck fermentations

In a study carried out in collaboration with the Research units of INRA Pech-Rouge and Montpellier, four yeast strains recommended to restart stuck fermentations were compared. An arrested must was obtained by incomplete fermentation of a highly clarified Chardonnay (5 NTU), de-oxygenized, without any nutrients addition (nitrogen 300 mg/l) for an initial potential alcohol of 12,5 %. This must was inoculated at 5 g/hl with a yeast strain known for its weak performances. An arrested fermentation followed with the following characteristics: 11,8 % vol. alcohol and 15,5 g/l residual sugar. The must was sulfited at 5g/hl was racked, divided into 1 liter fermentors then inoculated with the various restarting yeast strains at 30 g/hl. The tests were duplicated. Of all strains, INRA Narbonne n° 67 J, also known as Fermichamp® proved the most efficient (figure 5).

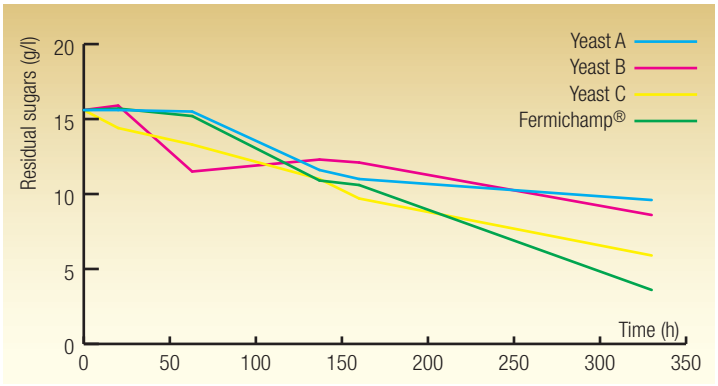

Figure 5: *Comparison of the efficiency of 4 yeast strains positioned on restarting fermentation on a Chardonnay must (average values of the duplicated tests).*

Fructophile yeast, the right choice

The majority of strains used to restart fermentation belong to the Saccharomyces cerevisiae bayanus subspecies, according to the old yeast classification. Despite their resistance to ethanol, these strains, like the majority of S. cerevisiae, have a greater affinity for glucose resulting in failure to complete fermentations to dryness. This difficulty increases for low residual sugar contents musts where fructose is largely predominant.

The strain n° 67 J, not only has an alcohol tolerance above 16 % but also has a greater capacity to ferment fructose than most selected enological yeast strains. A close monitor of the respective glucose and fructose contents during fermentation proved that the use of 67 J allowed an almost simultaneous consumption of both sugars (table 2). The combination of DSM production technology allowing to achieve maximum yeast viability and Fermichamp® enhanced affinity for fructose makes this strain the ideal yeast to restart stuck fermentations.

	Reference yeast strain (7013)	Fermichamp®
Initial	50	50
Mid-fermentation	70	55
End of fermentation	95	60

Table 2: *Relative concentration in fructose (in % of total residual sugars).*

Interest of the combined use of an adapted strain and efficient yeast hulls

The Chardonnay must described above was used to compare 2 methods of restarting stuck fermentations:
- "traditional" treatment: SO_2 5g/hl, racking and re-yeasting.
- "complete" method: SO_2 2g/hl, 20 g/hl yeast hulls, racking, re-yeasting.

For the 4 strains tested, the complete method allowed faster and more complete sugar consumption, the best results being obtained with Fermichamp® (figure 6).

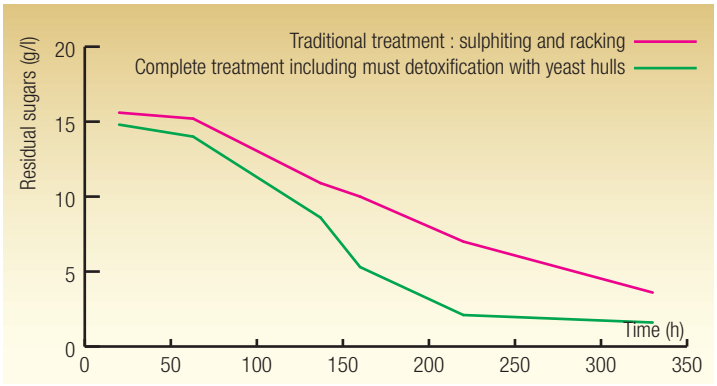

Figure 6: *Comparison of two methods to restart stuck fermentations with yeast hulls Fermichamp®.*

The positive effect of yeast hulls treatment was empathized with the other yeast strains (figure 7), proving the positive impact of yeast hulls in restarting stuck fermentations and this independently from their cause.

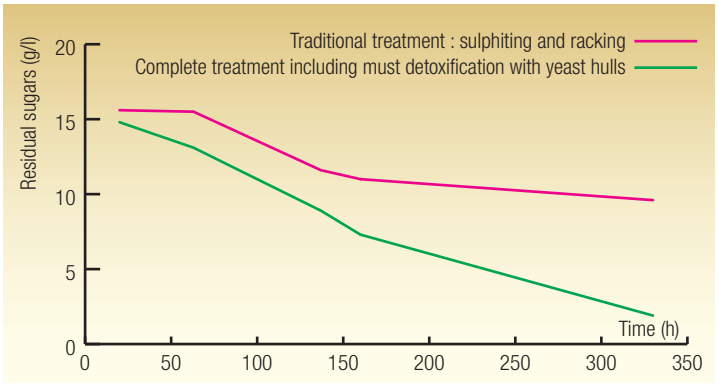

Figure 7 : *Comparison of 2 methods to restart stuck fermentations traditional (sulphiting and racking) and complete including must detoxification with yeast hulls(Yeast A).*

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Conclusion

When, in spite of all the precautions taken, a stuck of fermentation occurs, it is essential to restart it in a timely fashion in order to avoid wine spoilage.
With the joint use of Extraferm® yeast hulls and the fructophile yeast Fermichamp®, DSM offers a solution that proved to be the most efficient both in lab and production conditions.

Acknowledgements:
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Stuck fermentation, what to do?

Protocole for a 100 hl tank

On the arrested tank

1 • Add 2 to 3 g/hl (20-30 ppm) of SO_2 and combine with Delvozyme® 25-30 g/hl (2 to 2.5 lb/1000 gal).
2 • Add 30 to 40 g/hl (2,5 to 3.5 lb/1000 gal) of Extraferm® yeast hulls.
3 • Warm the tank up to 20° C (68° F).
4 • After ten to twelve hours, rack of the heavy lees.
5 • In the mean time prepare the yeast.

Preparing the yeast

1 • Add 1,5 kg of sugar to 30 liters of water at 35 - 38° C (1.25 lb of sugar to 3 gal of water at 95 -100° F).
2 • Add 3 kg (2,5 lb) of Fermichamp® to this solution.
3 • Leave to swell for 30 minutes.
4 • Add 40 liters (4 gal) of water at 40° C (104° F).
5 • Mix 10 kg of sugar and 14 liters of the arrested wine and add 45 grams of Maxaferm® (9 lb of sugar and 1.5 gal of the arrested wine and add 0,05 lb of Maxaferm®).
6 • Blend the re-hydrated yeast into the sweetened stuck wine.
7 • Keep at 20° C (68° F) for 24 h until 995 specific gravity (9 % alcohol).
8 • Incorporate this active yeast mixture to the "detoxified" tank.

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