Problem Fermentation and Yeast Hulls*

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Premature cessation of an alcoholic fermentation, commonly known as a stuck fermentation, is a serious winemaking problem. Restarting a stuck fermentation is often difficult and time consuming, but more importantly, it creates a favorable condition for the growth and activity of spoilage microorganisms. There are several factors that are responsible for fermentation problems. Some of them include:

1. Very high must sugar content
2. Nutrient deficiency in must
3. Insufficient concentration of yeast
4. Using yeast starter culture which is poor in health and vigor
5. Excessively clarified must
6. Extremely low or very high fermentation temperature
7. Presence of pesticide residue or other yeast inhibitors produced by mold- infested grapes

Understanding and manipulating the factors listed above should be helpful in preventing a stuck fermentation.

Fatty Acids

In some cases, even if the limiting factors mentioned above are absent, fermentation may cease prematurely. This can be caused by certain substances produced by yeast during the normal course of fermentation. Ethanol produced during fermentation is a well-known yeast inhibitor.

Fatty acids, such as decanoic and octanoic acids, are also formed during fermentation. These compounds, along with ethanol, are toxic to the yeast. When the concentration of these fatty acids reaches a certain critical level, a stuck fermentation results.

Fatty acids participate in the synthesis of sterols. (Sterols are important constituents of the cell membrane; they influence its stability and function.) Under aerobic conditions the fatty acids are used up in sterol production. However, under anaerobic conditions (fermentation), the sterol synthesis slows down and finally stops. Decanoic acid accumulates in the cell wall. This adversely affects cell membrane function, consequently sugar metabolism diminishes and fermentation ceases.

Yeast Hulls

Yeast hulls are also called yeast ghosts. Essentially they are a cell wall/membrane complex. They have the ability to adsorb the fatty acids and thus reduce their inhibitory effect. When yeast hulls are added to the fermenting must they adsorb the fatty acids and thus permit the active yeast cells to metabolize a greater quantity of sugar. This consequently prevents stuck fermentation.

Importance of Yeast Hulls

The phenomenon of fatty acid adsorption by yeast hulls was demonstrated by Lafon-Lafourcade et al., (1984). In their experiment, various levels of yeast hulls were added to a sterile medium containing 10% ethanol and known amounts of several fatty acids and their esters. After a period of 24 hours, the medium was analyzed for fatty acids. The data regarding the percent acid adsorbed in response to yeast hull addition is shown in Table 1.

Table 1. Adsorption of octanoic and decanoic acids by yeast hulls in a synthetic medium.

Weight of Yeast Hulls added in g/L	**Percent acids absorbed**	**Percent acids absorbed**
	octanic	**decanoic**
0.2	1.2	20.2
0.5	4.5	40.7
1.0	7.2	54.5

Data from Lafon-Lafourcade et at., (1984).

The results given in Table 1 clearly indicate the greater adsorption of decanoic acid when increasing levels

of yeast hulls were added to the medium.
The property of yeast hulls to adsorb fatty acids in a fermenting must has many enologically important implications. Their role in avoiding potential stuck fermentations has already been mentioned. The yeast hulls can also be effective in reactivating a stuck fermentation.

In another experiment Lafon-Lafourcade et al., (1984) added yeast hulls to a stuck wine at the rate of 0.5 g/L. The wine was inoculated with yeast @ 10^6 cells/ml. The fermentation progress was measured by determining the residual sugar content of the wine over a period of several days. Their results are given in Table 2.

Table 2. Effect of yeast hulls on inducing fermentation.

	Days following yeast hull addition @ 0.5 g/L.			
	0	**9**	**16**	**36**
	Sugar content g/L			
Stuck Wine	67	57	36	13
Stuck Wine & Yeast Hulls	67	53	24	1.4

Observations given in Table 2 indicate that the addition of yeast hulls to the stuck wine resulted in a relatively rapid reduction of residual sugar. By the end of the 36-day period the treated wine showed a lower sugar level than the control.

In addition to avoiding stuck fermentations and inducing fermentation in stuck wines, yeast hulls are also effective in other situations. These include fermenting must with initially high sugar content, must containing inhibitory compounds (e.g., pesticide residue), must infected with Botrytis mold, and must fermented at high temperatures (>93.2°F or 34°C).

Using yeast hulls is important in fermenting Vignoles must under Missouri conditions. As is well known, this variety is susceptible to Botrytis rot, and it tends to ripen with a relatively high amount of sugar. High must sugar and the presence of inhibitory compounds such as botryticine, can both cause problems during fermentation. For this reason the use of yeast hulls in fermenting late harvest or Botrytis infected Vignoles must should be considered.

The amount of yeast hulls commonly used is in the range of 0.2 to 0.3 g/L. In the case of restarting a stuck fermentation a higher dose may be required. Generally when determining the amount of yeast hulls to use, one should follow suppliers' recommendations.

*Previously published in *Vineyard & Vintage View*, Mountain Grove, MO.