



Enology Notes #162

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To: Grape and Wine Producers

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1. Enology Notes Index.

As a reminder, the *Enology Notes* Index contains an alphabetical listing of all subjects covered in this series, including those of importance for the upcoming season, such as maturity. Go to www.vtwines.info. Click Enology Notes Index

2. The Nature of Wine Lees.

During aging *sur lie*, yeast components are released into the wine. These macromolecules can positively influence structural integration, phenols (including tannins), body, aroma, oxygen buffering, and wine stability. Some macromolecules can provide a sense of sweetness as a result of bridging the sensory sensations between the phenolic elements, acidity, and alcohol, aiding in harmony and integration.

Mannoproteins in the yeast cell wall are bound to glucans (glucose polymers), which exist in wines as polysaccharide and protein moieties (Feuillat, 2003). They are released from the yeast cell wall by the action of an enzyme, β -1,3-glucanase. β -1,3-glucanase is active during yeast growth (fermentation) and during aging in the presence of non-multiplying yeast cells. Stirring increases the concentration (Feuillat, 1998).

Lees and mannoproteins can impact the following:

- integration of mouthfeel elements by interaction between structural/textural features
- reduction in the perception of astringency and bitterness (Escot et al., 2001; Saucier, 1997)
- increasing wine body
- encouraging the growth of malolactic bacteria and, possibly, yeasts
- preventing bitartrate instability (Lubbers et al., 1993; Moine-Ledoux, 1996; Moine-Ledoux and Dubourdieu, 2002; Waters et al., 1994)
- interacting with wine aroma (Lubbers et al., 1994)

The amount of mannoprotein released during fermentation is dependent on several factors, including the following:

- Yeast strain: Large differences are noted among yeasts in the amount of mannoproteins produced during fermentation and released during autolysis.
- Must turbidity: Generally, the more turbid the must, the lower the mannoprotein concentration (Guilloux-Benatier et al., 1995). Mannoproteins released during fermentation are more reactive than those released during the yeast autolysis process in modifying astringency. This helps provide additional justification for measuring the non-soluble solids of juice pre-fermentation.

Wines aged on lees with no fining have mannoproteins present, while those fined prior to aging have a large percentage of mannoproteins removed. Periodic stirring *sur lie* increases the mannoprotein concentration, and increases the rate of β -1,3-glucanase activity. Generally, yeast autolysis is relatively slow (in the absence of glucanase enzyme addition) and may require months or years to occur, limiting the mannoprotein concentration (Charpentier and Feuillat, 1993).

The impact of lees components such as polysaccharides on astringency can cause an increase in the wine's volume or body. Lees contact is particularly effective at modifying wood tannin astringency by binding with free ellagic tannins (harsh tannins). *Sur lie* storage can reduce the free ellagic acid by as much as 60% (via precipitation), while increasing the percentage of ellagic tannins bound to polysaccharides by 24% (Ribéreau-Gayon et al., 2000).

In the Burgundy and other regions, red wines are aged on their lees in conjunction with the addition of exogenous β -1,3-glucanase enzyme. This procedure is an attempt to release mannoproteins, which winemakers believe may enhance the suppleness of the wine, while reducing the perceived astringency.

Several alternative methods of increasing mannoprotein levels have been suggested (Feuillat, 2003), including the following:

- selection and use of yeast which produce high levels of mannoproteins during the alcoholic fermentation
- yeast which autolyze rapidly upon completion of alcoholic fermentation
- addition of β -1,3-glucanase to wines stored on lees
- addition of exogenous mannoproteins (proprietary products), prepared from yeast cell walls, to wines on lees

3. Lees Management Considerations.

Table 1 shows some important practical winemaking considerations regarding lees management.

During fermentation, the level of macromolecules continually rises, peaking at approximately 270 mg/L, by which time they contain 82% sugar and only 18% protein (Feuillat, 2003).

Guilloux-Benatier et al. (1995) found a relationship between the degrees of must clarification and the amount of yeast macromolecules recovered in the wine. When the must was not clarified, there is no production of yeast macromolecules.

Table 1. Lees Management Considerations

Non-soluble solids level
Method of stirring
Frequency and duration of stirring
Type and size of vessel
Duration of lees contact
MLF
Timing and type of racking
SO ₂ timing and level of addition
Frequency of barrel topping

However, mild must clarification, such as cooling for 12 hours, increased the amount of yeast-produced macromolecule production by 76 mg/L, and heavy

must clarification, such as bentonite fining, increased the production by 164 mg/L. Boivin et al. (1998) found that the amount of macromolecules produced will vary between 230 and 630 mg/L, and that they will contain 20 – 30% glucose and 70 – 80% mannose.

During lees contact, the composition of the wine changes as the yeast commence enzymatic hydrolysis of their cellular contents. One important feature is the process of proteolysis, whereby proteins are hydrolyzed to amino acids and peptides. These compounds result in an increase in the available nitrogen content of the wine. Amino acids can act as flavor precursors, possibly enhancing wine complexity and quality.

Yeast-derived macromolecules provide a sense of sweetness as a result of binding with wood phenols and organic acids, aiding in the harmony of a wine's structural elements by softening tannins.

It is important to differentiate between light lees and heavy lees. Heavy lees can be defined as the lees which precipitate within 24 hours immediately post-fermentation. They are composed of large particles (greater than 100 micrometers) and consist of grape particulates, agglomerates of tartrate crystals, yeasts, bacteria, and protein-polysaccharide-tannin complexes.

Light lees, on the other hand, can be defined as those that precipitate from the wine more than 24 hours post-fermentation. These are composed mainly of small particles (1- 25 micrometers) of yeasts, bacteria, tartaric acid, protein-tannin complexes, and some polysaccharides.

There is no value in storing wine on heavy lees. Indeed, such storage can result in off aroma and flavors, and a depletion of sulfur dioxide. Light lees storage, however, can have a significant advantage in structural balance, complexity, and stability.

Lees stirring and the frequency of stirring is important, both as a practical and stylistic consideration. Feuillat and Charpentier (1998) have demonstrated that periodic stirring of the wine while on lees increases the mannoprotein level and the amount of yeast-derived amino acids, and that wines aged on their lees in barrel exhibit an increase in colloidal macromolecules.

Stirring generates an oxidative process which increases the acetaldehyde content, and which may increase the acetic acid concentration. Stirring also changes the sensory balance between fruit, yeast, and wood by enhancing the yeast component, and reducing the fruit and, to a lesser degree, the wood component.

Additionally, stirring may have the effect of enhancing secondary chemical reactions, possibly as the result of oxygen pick-up. Stuckey et al. (1991)

demonstrated increases in both the total amino acid content and wine sensory score in wines stored for five months without stirring. The non-stirred wine was perceived to have greater fruit intensity.

MLF reduces the harshness of new oak and aids in the development of complex and mature flavors. Traditionally, stirring is continued until MLF is complete. After that, the lees are said to become more dense, which aids in clarification.

During barrel aging, what we are looking for is slow, well-managed, and controlled oxygenation. Some lees contact may allow for this oxygenation, and lees aid in the prevention of oxidation.

In Burgundy, wines are traditionally racked off the lees in March, usually the time when MLF is completed. Frequently this is an aerobic racking off the heavy lees, then back into wood on light lees, followed by an SO₂ addition. Leaving the wine on the light lees helps to nourish the wine. The addition of SO₂ helps to protect the wine from oxidation. A subsequent racking often occurs in early July, and is in the absence of air.

Timing of SO₂ additions, and the quantity of SO₂ added, are important stylistic considerations. Early use of SO₂ increases the number of components that bind to subsequent additions of SO₂. The addition of too much SO₂ counters the wood flavors and limits oxidation reactions, while too little SO₂ may allow the wine to become tired and over-aged.

Production considerations, such as the timing of MLF, the method of barrel storage, and time of bottling, are factors influencing SO₂ levels. Barrel topping is an aerobic process that can result in excessive oxidation. Additionally, wines that spend a second winter in the cellar tend to lose their aroma unless the wine is particularly rich.

Delteil (2002) compared two red wines. One wine was barrel-stored on light lees for 9 months; the other, racked several times prior to barreling, was stored for the same period without lees. These two Syrah wines differed significantly in their palate and aroma profiles.

The wine stored *sur lie* had a much lower perception of astringency and a greater integration of the phenolic elements. The *sur lie* wine also had a lower perception of oak character, resulting in a higher perception of varietal fruit.

Lees contact is particularly effective at modifying wood tannin astringency by binding with free ellagic tannins, thus lowering the proportion of active tannins. *Sur lie* storage can reduce the free ellagic acid by as much as 60%, while increasing the percentage of ellagic tannins bound to polysaccharides by 24% (Ribéreau-Gayon et al., 2000).

The following is a review of the impact of lees on wines. Many have been outlined in previous editions of Enology Notes available at www.vtwine.info.

a. Lees, Color and Mouthfeel. High lees concentration can reduce color, as a function of adsorption onto the yeast cell surface. Additionally, lees adsorb oxygen which can limit the anthocyanin-tannin polymerization, resulting in an increase in dry tannin perception. This may or may not be off-set by the release of lees components which can soften mouthfeel.

b. Lees and Wine Aroma. Aroma stabilization is dependent upon the hydrophobicity (ability to repel water molecules) of the aroma compounds. The protein component of the mannoprotein fraction is important for overall aroma stabilization (Lubbers et al., 1994). Such interactions can modify the volatility and aromatic intensity of wines.

When wine is aged on its lees with no fining, mannoproteins are present and are free to interact and to fortify the existing aroma components. When wines are fined prior to aging, mannoproteins are removed and will not be present to augment the existing aroma components. Additionally, when wines are cross-flow filtered, eliminating a certain percentage of macromolecules, the loss of color intensity, aroma, and flavor can be noted.

c. Lees and Oak Bouquet. Lees modify oaky aromas, due to their ability to bind with wood-derived compounds such as vanillin, furfural, and methyl-octalactones.

d. Lees and Oxidative Buffering Capacity. Both lees and tannins act as reducing agents. During aging, lees release certain highly-reductive substances which limit wood-induced oxygenation. Wines have a higher oxidation-reduction potential in barrels than in tanks. Inside the barrel, this potential diminishes from the wine surface to the lees. Stirring helps to raise this potential.

This is a primary reason why wines stored in high-volume tanks should not be stored on their lees. Such storage can cause the release of “reductive” or sulfur-containing compounds. If there is a desire to store dry wines in tanks *sur lie*, it is recommended that the lees be stored in barrels for several months, then added back to the tank (Ribéreau-Gayon et al., 2000).

e. Lees and White Wine Protein Stability. The greater the lees contact, the lower the need for bentonite or other fining agents for protein stability. It is not believed that lees hydrolyze grape proteins, or that proteins are adsorbed by yeast. Rather, lees aging produces an additional mannoprotein, which somehow adds stability. The production of this mannoprotein is increased with temperature, time, and frequency of stirring.

f. Lees and Biological Stability. Guilloux-Benatier et al. (2001) have studied the liberation of amino acids and glucose during barrel aging of Burgundy wine on its lees. Their studies were done with and without the addition of exogenous β -1,3-glucanase preparations. They found little or no increase in amino acids in wine stored on lees, versus wine stored on lees with the addition of β -1,3-glucanase.

Their most significant finding was an increase in glucose concentration, from 43 mg/L in the control wine, to 570 mg/L in wine stored on its lees, to 910 mg/L in wine stored on its lees with added β -1,3-glucanase. The finding of this relatively large amount of glucose led these authors to speculate that the growth of the spoilage yeast *Brettanomyces* in barreled wine may be stimulated by the availability of this carbon source.

g. Lees and Bitartrate Stability. Mannoproteins produced by yeast can act as crystalline inhibitors. The longer the lees contact time, the greater is the likelihood of potassium bitartrate stability.

4. Pre-Harvest and Harvest YAN Analysis.

Again this season, Virginia Tech's Enology Service Laboratory will conduct YAN and YAN-component analyses for the industry.

1. Email the Laboratory at EnologyServices@vt.edu to request processing bags and bottles
2. Include name, company, mailing address, and the number of sampling kits required
3. Collect juice samples at harvest, or grape berry samples from the vineyard pre-harvest*
4. Fill sample bottles to the indicated level, mix thoroughly to dissolve preservative
5. Ship samples overnight to the Laboratory; shipping delays will impact analysis results

*Complete information regarding sampling and berry-bag processing can be found on the VT Enology-Grape Chemistry Group website (www.vtwines.info) under Online Publications > [Maturity Evaluation for Growers](#).

The results are strongly dependent on **adequate** and **representative** sampling in the vineyard and proper sample processing.

Ship samples to:

Wine/Enology-Grape Chemistry Group
Enology Service Lab
Attn: Ken Hurley
Rm. 113, FST Bldg.

Virginia Tech (0418)
Blacksburg, VA 24061

For more information on available analyses and analytical panels, including prices, please see the Enology-Grape Chemistry website at www.vtwines.info.

5. Winery Planning and Design, Edition 16, Available.

This publication, in CD format, is the result of a number of short courses and seminars, covering various aspects of winery planning, in several wine regions around the country. While not regionally specific, the information provided is from a number of authoritative sources, covering such diverse topics as sustainable design, winery equipment, and winery economics. *Winery Planning and Design*, Edition 16, is available through the industry trade journal *Practical Winery and Vineyard* (phone 415-479-5819, email: tlv100@sonic.net). The entire index and additional information is available at www.vtwines.info.

6. Technical Study Tour – Bordeaux, France, November/December 2012

Hosts: Professors Pascal Durand and Bruce Zoecklein

Objectives: Focus on grape growing and winemaking techniques of Bordeaux.

Red grapes : Cabernet Sauvignon, Cabernet Franc, Merlot noir, Petit Verdot, Carmenere, and Malbec

White grapes : Sauvignon blanc, Sémillon, Muscadelle, Merlot blanc , Colombard and Ugni blanc

Dates: Sunday, December 2 to Sunday, December 9, 2012, with optional pre-tour visit to Vinitech and Southern Spain

Program : A week in the Bordeaux Region.

The tour will be a mixture of vineyard and winery visits, tastings, and meetings. It will offer the opportunity to meet with top grape growers and winemakers of the Bordeaux. Casual lunches in the country and dinners in fine restaurants with the leading producers will offer the opportunity to match wine and food, and discuss important industry issues.

Schedule:

Optional: An optional 3-day pre-tour is offered to participants interested in Southern France and attending Vinitech, the largest wine industry equipment show in Europe. This part of the tour will also include a trip to

Alta Rioja in Spain (Tempranillo, Grenache, Viura and Malvasia grapes will be discussed and highlighted).

- **Sunday, Dec. 2: Meet at the hotel in downtown Bordeaux in the afternoon** – Presentation and welcome dinner.
- **Monday, Dec. 3: Focus on questions about grapes and wines.** Morning at Conseil Interprofessionnel des Vins de Bordeaux and the Institut des Vins de Bordeaux (meeting winegrowers and technical support personnel) – Afternoon in Graves Graves.
- **Tuesday, Dec. 4: Focus on Cabernet Sauvignon.** Day in Medoc (meet with winegrowers).
- **Wednesday, Dec. 5: Focus on Cabernet Franc and Merlot.** Day at Pomerol and St. Emilion (meet with winegrowers).
- **Thursday, Dec. 6: Focus on other Bordeaux blends and sparkling wines.** Day in Blayes and Libourne vineyards (meet with winegrowers).
- **Friday, Dec. 7: Focus on sweet Bordeaux.** Day at Sauterne and Ste. Croix du Mont (meet with winegrowers).
- **Saturday, Dec. 8: Focus on wine tourism at the new Center of Bordeaux wines.** End of the tour after lunch.

Lodging : Same hotel in downtown Bordeaux from Sunday, Dec. 1, until morning of Saturday, Dec. 8. Hotel at Paris airport on Saturday evening, Dec 8.

Transportation provided by comfortable tour bus.
Technical language translation will be provided.

Cost: 2350 Euros (includes hotel, all meals, local transportation, tastings, and visits).

Not included: airfare and/or other transportation to and from Bordeaux.

Discount if sharing room: 300 Euros.

Optional Pre-Program Schedule:

Wednesday, Nov. 28: Meet at the hotel in downtown Bordeaux for dinner.

Thursday, Nov. 29: Vinitech at Bordeaux.

Friday, Nov. 30/Saturday, Dec. 1: Tour of wineries in Rioja Alta (Spain).

Sunday, Dec. 2: Back to Bordeaux in the early afternoon.

Additional cost for optional tour: 1000 Euros

Who should participate:

This is the 7th Technical Study Tour we have organized. These programs have several restrictions:

- This is a technical study tour. Only those directly involved in commercial grape growing and/or winemaking can attend.
- This tour is restricted to a maximum of 18 people.
- This offering is provided on a first come, first served basis. To secure a slot, you must send a deposit of \$100 payable to Dr. Bruce Zoecklein.
- Refunds will only be provided if this tour participation number is fewer than 12 people and the tour is cancelled.
- This opportunity is open to grape growers and wine producers from any region.
- Information regarding previous Technical Study Tours can be found on my website at www.vtwines.info.
- Questions should be directed to Dr. Bruce Zoecklein at bzoeckle@vt.edu.

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