

Lees Ageing of Red Wines: The Enzymatic Route*

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Polysaccharides play a very important role in determining wine quality. The exact role depends on polysaccharide size and origin.

In this paper:

- We shall attempt to identify these polysaccharides, to describe their role and to address the effects of various wine-making operations.
- We shall examine how various enzymatic activities affect these polysaccharides.
- Finally, we shall evaluate the use of enzymes to improve red wine ageing.

Origin of Polysaccharides

Grape Polysaccharides

The polysaccharide fraction of wines consists essentially of the following: Compounds from the pectin- and cellulose-containing walls of the grape berry. These compounds are generally released during winemaking operations: crushing, punching-down, tank rotation and pressing, etc.

The most common grape polysaccharides in wine are type-II arabinogalactan-proteins (AGP), type-I rhamnogalacturonan (RG I) and type-II rhamnogalacturonan (RG II). Arabinans have also been identified in wines.

Yeast Polysaccharides

The yeast cell wall represents 15-25% of the cell by dry weight. It is composed essentially of polysaccharides (90%) and also includes proteins and lipids. The exact composition depends on yeast species.

In a literature review, *Ballou (1982)* cited the composition and structure of the carbohydrate macromolecules in *S. cerevisiae* cell walls, as well as the changes in the cell wall during the cell life cycle. Cell-wall polysaccharides in yeast are

mostly glucans, mannoproteins and chitin. In *S. cerevisiae*, cell-wall glucan is actually a complex mixture of two glucans, as shown by *Bacon and Farmer (1968)* and then confirmed by *Manners et al. (1973)*. These authors found that the principal glucan in *S. cerevisiae* consists of β 1 \rightarrow 3 linked glucose units with β 1 \rightarrow 6 side chains. The other is a branched β 1 \rightarrow 6 glucan with some β 1 \rightarrow 3 linkages. During fermentation, yeasts also release mannoproteins. Some yeast strains produce more than others.

Polysaccharides from *B. cinerea*

In 1904, *Laborde* gave the name "dextran" to the colloidal substance produced by the mould *Botrytis cinerea*. However, as clearly shown by *Dubourdieu (1982)*, this compound is actually a β -glucan. The main-chain glucose units are characterised by β 1 \rightarrow 3 linkages, whereas the side chains are attached to the main chain by β 1 \rightarrow 6 linkages. This configuration is rather similar to that found with *S. cerevisiae* yeast.

Effects of Polysaccharides in Wine

Several authors have discussed the positive and negative effects of polysaccharides in wine:

- Fuller body and improved mouthfeel, owing to an increase in the macromolecular content of the wine (*Feuillat, 1987*)
- Increased aroma expression (*Lubbers et al., 1993*)
- Decreased astringency in some red wines (*Vasserot and Maujean*)
- Improved colour stability (*Saucier, 1997*)
- Improved protein and tartrate stability (*Dubourdieu and Moine-Ledoux, 1995*)
- Decreased volatile thiol content, owing to disulphide bond formation between mannoproteins and the thiol groups (*Lavigne and Dubourdieu, 1996*)
- Chelation of heavy metals (rhamnogalacturonan II)
- Protective colloid action
- Reduced filtration rates (*Villetaz, 1982*).

Grape Polysaccharides

The role of grape polysaccharides is less well known, at least as concerns their positive aspects. Recent articles (*Pellerin et al., 1996*) describe their structure. The use of extractive enzymes increases the release of cell-wall degradation products, including the precursors of soluble polysaccharides.

It has been shown that these compounds interact with tannins (*Amrani, 1993, Saucier, 1997*). These authors conclude that polysaccharides play an important role in stabilising anthocyanins and in promoting reactions between polyphenols and the proteins responsible for astringency. More generally, experience has shown that adding grape polysaccharides to wine can lead to a noticeable "softening" (*Amrani, personal communication*).

The negative effects of pectin on wine clarification and filterability are well known. It is common practice to add pectolytic enzymes to press wines in order to hydrolyse pectin.

Yeast Polysaccharides

Several studies have investigated the polysaccharides that originate from yeast cell walls. Studies on lees fining (Germany and Burgundy), gross lees ageing (Burgundy) and fine lees ageing (Muscadet) have elucidated some of the physical and chemical phenomena that occur as a result of these winemaking practices. The observation of traditional red wine-making practices (barrelling down straight from the press, MLF in the springtime, etc.) has led to some experiments with the lees ageing of red wines. Yeast polysaccharides, like their grape counterparts, affect the body and structure of red wines. In addition, they surround wine tannins and thus decrease astringency. However, yeast glucans negatively affect filtration by decreasing flow rates through the filter.

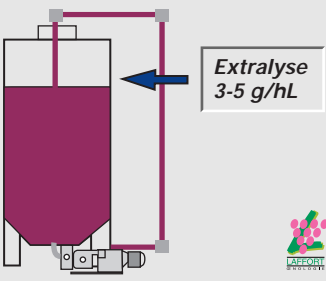
This partly explains the difficulties encountered when filtering young wines.

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Polysaccharides from *B. cinerea*

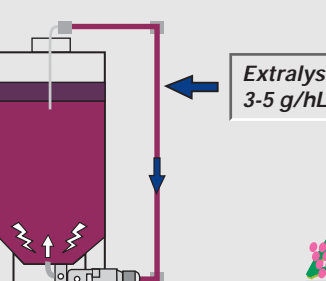
The glucan produced by *B. cinerea* has an exclusively negative effect on wines. It is a major obstacle for filtration. According to *Villetaz (1982)*, a glucan content as low as 3-4 mg/L can cause filtration problems. In addition to the added expense, these difficult filtrations also decrease the overall polysaccharide content of the wine, thus stripping the wine of its body.

Figure 1: Running Off the Wine Before the End of AF.



- Add enzyme as soon as AF is finished
- Keep lees in suspension for 3-5 weeks
- Sulphite addition and racking at winemaker's discretion
- No negative interaction with MLF

Figure 2: Post-AF Maceration. Circulation from under the Cap.



- At the end of AF, insert a racking wand all the way through the cap. Circulate wine from top to bottom of tank.
- Keep lees in suspension for 3-5 weeks
- Drawing off, sulphite addition and racking at winemaker's discretion
- No negative interaction with MLF

Influence of Various Enzymatic Activities

As we have already stated, traditional winemaking techniques promote the release of grape and yeast polysaccharides into the wine. Unfortunately, they also increase glucan content! The length of these traditional operations leads to greater extraction. In the past, grapes were often crushed in the vineyard, transport times were long and skin contact lasted for much longer periods (wine drinkers accepted more astringent wines). In addition, polysaccharide extraction was favoured by the direct transfer of wines into barrels after pressing, the inclusion of some press wine and the delay in MLF onset until spring. However, such practices are now much rarer, since they do have some downsides and since wine drinkers now demand fleshy, charming wines for early drinking rather than tannic, densely structured ones.

In light of the different roles played by polysaccharides, we had the idea several years ago of adding pectolytic activities (PME-PG-PL) to the β -glucanase in the **Extralysse** enzyme preparation. As such, the advantages of the traditional techniques can be obtained, while still complying with modern economic and

quality constraints. By catalysing (accelerating) the natural process of polysaccharide solubilisation, this enzyme preparation enables proper control and reproducibility under the best possible conditions.

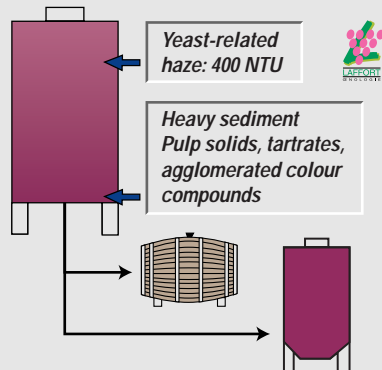
This technological advance is as decisive and important as the use of maceration enzymes. The pectolytic activities ensure the breakdown of pectin chains and therefore aid in polysaccharide solubilisation.

The β -glucanase decreases the glucan content, thus helping to alleviate filtration problems. It also accelerates the natural autolysis of yeast cell walls, with the release of the vacuolar contents (amino acids, peptides and vitamins) and some cell-wall components (mannoproteins).

This release of nutrients also helps to promote bacterial growth and thus malolactic fermentation. Finally, it should be noted that lees ageing leads to the release of peptides and amino acids, such as glutathione and cysteine, which have an anti-oxidant effect. These compounds protect the wine from overly rapid oxidation, and they retard the appearance of brick-red colours and other characteristics of older wines (*Vivas and Saint-Cricq de Gaulejac, 2000*).

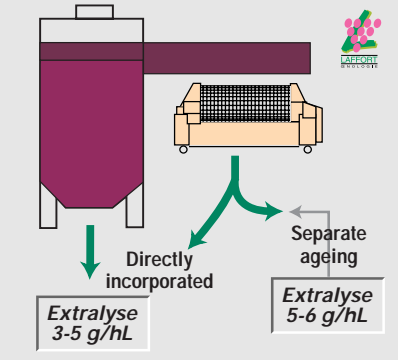
Consequently, all other conditions being

Figure 3: Settling of Red Wines After Running Off.



- Extralysse promotes rapid settling of solid matter
- It is recommended to settle wines after drawing off, particularly for short macerations
- Add active culture for rapid MLF

Figure 4: Press Wine.



- Press wines contain yeast of sufficient quality. Add enzyme under press (P1, P2)
- Allow wine to settle and rack
- Keep lees in suspension for 3-5 weeks with frequent pump-overs
- Thanks to their improved quality after treatment, press wines can often be blended into free-run wines
- No negative interaction with MLF

equal, enzyme addition will lead to wines with:

- More polysaccharides in solution
- Greater stability
- Better filterability
- Rounder mouthfeel.

Procedure for Use

Polysaccharide extraction can be regulated by modulating the time and type of enzyme addition. The main sources of polysaccharides are as follows:

- Grape skins, mostly in the "cap"
- Grape solids from the pulp, which are the main source of haziness in young wines
- Lees, which in addition to grape particles, contain a large fraction of dead yeast cells.

The substrate for extraction is greatest

in quantity when maceration is continued after fermentation. Under such conditions, **Extralyse** acts both to release and to solubilise the polysaccharides. Keeping the lees in suspension also helps to get the maximum benefit from the yeast cell walls.

When added after the wine has been run off (**figure 1**), only the solubilisation effect remains. It can be advantageous to stir the lees before running off (**figures 2 and 3**). Finally, use of **Extralyse** can be particularly beneficial for press wines (**figure 4**).

In addition to promoting wine clarification and helping to break down the pectins extracted during pressing, **Extralyse** also accelerates the autolysis of yeast entrained during racking, thus enabling all of the benefits described above. ■



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