Fining during fermentation: focus on white and rosé

Advantages of fining in must rather than wine on aroma and colour

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The most common timing for fining is in the juice stage or in wine, but a multitude of research supports fining during fermentation as a beneficial practice. Fining is a generic term for the removal of a particular set of compounds, and there are various methods to accomplish this. Combinations of fining agents (Figure 1) can have a targeted effect on undesirable compounds without affecting nitrogen levels. Both micronutrients and nitrogen can be replaced through the addition of organic nitrogen sources, but key aroma compounds like thiols are lost indefinitely if they are not protected from oxidisable phenolics early on in the juice stage (Coetzee *et al.* 2013). Wine is a complex matrix of proteins, colloidal matter, sugars, acids and phenolic compounds. Fining removes unwanted components from juice or wine. This may be for the purpose of clarification, removal of oxidisable and non-oxidisable compounds which can affect colour, bitterness and other off flavours. Fining can improve wine stability in a number of ways and improve wine from an organoleptic point of view. Besides having a clarifying effect, fining leads to changes in the polyphenolic structure of wines and, in red wines, improves the stability of colouring matter by eliminating particles likely to precipitate later in bottle (Lagune-Ammirati and Glories 1996). Fining also helps reduce the microbial load of the wine (Murat and Dumeau 2003).

TAKE HOME POINTS

- Oxidisable phenolics (mainly flavonoids and phenolic acids) can affect colour by turning brown. These brown oxidised phenolics can scavenge important aroma compounds
- Fining during fermentation may prevent aroma and colour modification by fining out oxidisable phenolics early on
- Each wine is unique and will require a tailored combination of fining agents suitable for the desired wine style
- CO_2 from the fermentation will not protect phenolics from oxidising
- Time from grape to bottle – there is often less time to stabilise colour, which results in a greater need to fine.

WHAT ARE THE KEY AROMA COMPOUNDS THAT NEED PROTECTION?

Thiols are a key part of expression in many varietals, the most notable being Sauvignon Blanc. Thiols are relatively unexpressed in grape juice, but develop via yeast metabolism during alcoholic fermentation (Dubourdieu *et al.* 2006). The yeast strain plays a critical role in the formation of the thiols from precursors found in grapes. Cysteinylated and glutathionylated precursors have a high chemical stability against oxidation (Roland *et al.* 2010). In Sauvignon Blanc, 3-sulfanylhexanol (3SH), 3-sulfanylhexyl acetate (3SHA) and 4-sulfanyl-4-methylpentan-2-one (4MSP) are elemental, but have also been linked to the blackcurrant aroma of red wine (Rigou *et al.* 2014). 3SHA is formed from the acetylation of 3SH by the yeast during fermentation (Swiegers *et al.* 2007).

Methoxypyrazines are grape-derived and important contributors to green pepper, asparagus, grassy, herbaceous and vegetative characteristics. Three main methoxypyrazines occur in wines, namely 3-isobutyl-2methoxypyrazine (IBMP), 3-isopropyl-2-methoxypyrazine and 3-sec-butyl-2-methoxypyrazine (Marais 1994). These aromas are not modified by fermentation, and were shown to be present even after oxidative handling in the absence of SO_2 (Coetzee *et al.* 2013).

Monoterpenes are plant-derived, have characteristic floral, fruit and citrus aromas in the form of geranoiol, linalool, nerol and alpha-terpineol, and are present in aromatic muscat varieties (Mateo and Jiménez 2000). Terpenes are normally glycosylated and non-volatile in their glycosylated form. These may be released over the course of the fermentation or with commercial enzymes (Rusjan *et al.* 2016). Esters, higher alcohols and volatile acids are produced exclusively by microbial intervention (this level is subject to genera, species and strain variation) (Sumby *et al.* 2010). Esters are much less prone to oxidation than thiols and can contribute fruit aromas.

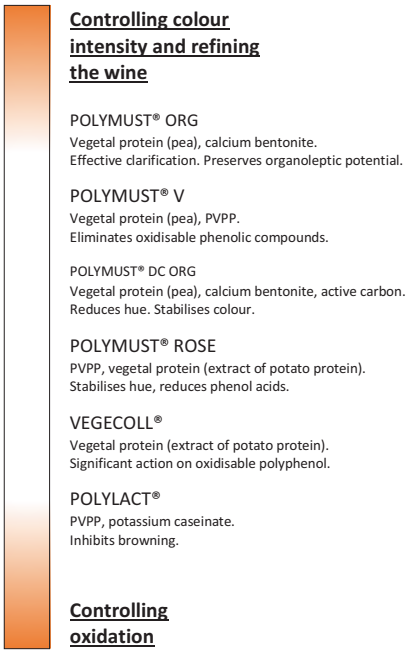

Figure 1. Different applications of fining combinations.

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TYPES OF FINING AGENTS

Fining agents can be divided into two categories: Proteinaceous and non-proteinaceous (Table 1). Their interaction with wine compounds can be in the form of a chemical bond, absorption and adsorption or electrostatic interaction. A chemical bond formation will bind to the compound in question and normally precipitate. Absorption and adsorption carries no electric charge and captures the compounds upon its structure. Electrostatic interactions involve the fining agent and the compound having opposite charges, attracting the larger molecules which combine with the fining agent and settle out.

Table 1. Types of fining agents and their respective properties

	Fining agent	Charge
Proteinaceous	Gelatine	Positive
	Isinglass	Positive
	Casein	Positive
	Egg white	Positive
	Pea	Positive
	Potato	Positive
Non-proteinaceous	Bentonite	Negative
	Tannins	Negative
	Silica	Negative
	PVPP	No charge
	Carbon	No charge

WHAT ARE THE BENEFITS OF FINING IN JUICE RATHER THAN FINING IN WINE?

The removal of oxidisable phenolics are key to preserving aromas and, importantly, preventing the wine from oxidising and turning brown. Elimination of the phenol acids and flavonoids prevent the formation of o-quinones (brown compounds; Figure 2). If the majority of compounds that can be oxidised are taken out, then there is much less to oxidise. Apart from changing the colour, o-quinones can then react with thiols, rendering the bound thiol inodorous, thereby removing important aromas (Singleton 1987). When the must is fined earlier rather than later in the wine, the oxidisable phenolics can be removed before any effect on aroma and colour is caused. When fining wine, the oxidisable phenolics present may already have had an impact on aroma and colour and the rate used has to be much lower, as the fining at this point may have a much harsher effect. Glutathione is found in yeast and juice and can play a role in aroma protection via means scavenging oxygen and can bind to the oxygen in o-quinones forming a stable compound (Cheynier *et al.* 1993).

During fermentation a fining agent is able to be kept in suspension due to the agitation caused by the fermentation

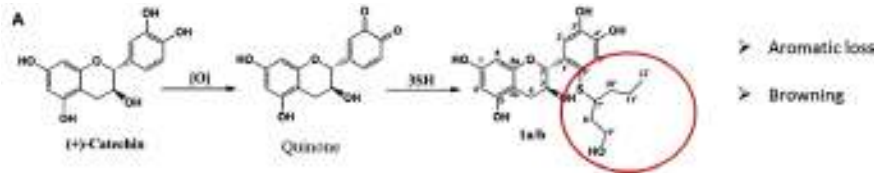

Figure 2. Prevention of the formation of quinones which can trap volatiles aroma.

and, as a consequence, be thoroughly distributed throughout the must. The desired aromatic outcome can be optimised by managing the right level of nephelometric turbidity unit (NTU) for the yeast and fining action. Figure 3 is a trial conducted in 2014 on the Sauvignon Blanc free run fraction, demonstrating an increase in thiols with the turbidity regulation and addition of a fining agent. The purpose of adding the fining agent was to eliminate oxidisable phenolics in the juice which could subsequently bind to volatile thiols in their oxidised form. The yeast strain Zymaflore X5® (*Saccharomyces cerevisiae*) was inoculated into the same must with incrementing turbidities: 150, 200 and 250 NTU (fluffy lees were added back to adjust the NTU). Each of these fermentations were conducted with and without the addition of an extract of potato protein (Vegecoll®) at 30ppm. Both yeast assimilable nitrogen (YAN) and lipid content were adjusted to the same level. When conducted with a second strain of *Saccharomyces cerevisiae* (Figure 3b) the levels of thiols released in the same must were much higher, ranging from 46–49% increase in thiols, rather than 14–24% for the first yeast strain.

The thiol fraction was measured three months after the end of alcoholic fermentation (Figure 4) for both Zymaflore X5 and Zymaflore Delta®. In all cases there was a better preservation in thiols at the end of the three-month period where Vegecoll was used.

With the introduction of crossflow filtration, it can be tempting to skip the fining stage. Crossflows can make the wine clear, but not stable. When floating with a fining agent, there is the added benefit of fining at the same time.

Grapes naturally have glutathione present, but it can also be released from the yeast. Glutathione is important because it can also bind to phenolic acids and prevent them from oxidising. Glutathione can be taken up by yeast, so any nitrogen deficiency will incur the loss of glutathione. Fining agents do not have an impact on glutathione levels, making fermentation an ideal time to fine.

MULTIPLE ADDITIONS: FINING IN JUICE AND DURING AF

Figure 5 was a trial conducted in France in 2015 on Sauvignon Blanc pressings. The control had managed oxygenation

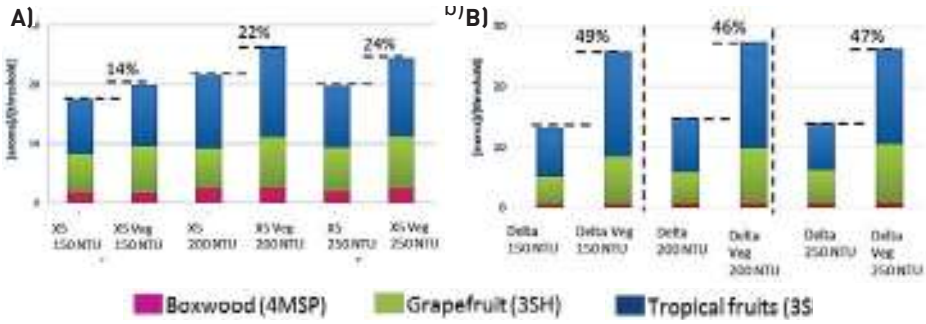

Figure 3. Thiols (concentration/threshold) incrementing must turbidities and with/without Vegecoll®, fermented with A) Zymaflore® X5 yeast and B) Zymaflore® Delta.

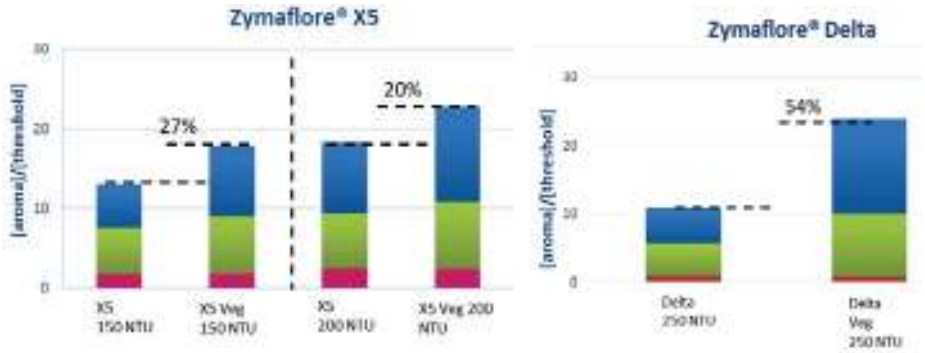

Figure 4. Thiols (concentration/threshold) measured at the end of alcoholic fermentation and three months after alcoholic fermentation.

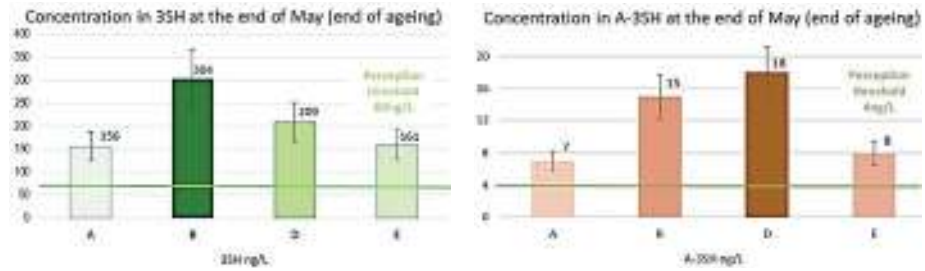

Figure 5. Trial variations: A: Control, juice with controlled oxygenation and settling; B: Vegecoll® at 200ppm on the juice prior to settling, protection from O_2; D: Vegecoll® at 150ppm on the juice prior to settling + 30ppm in alcoholic fermentation, protection from O_2; E: Vegecoll® at 50ppm in alcoholic fermentation, protection from O_2. Press juice 2015, Sauvignon Blanc, winemaking in used barrels.

and settling without any fining agent (A). Overall this variant showed the lowest levels of 3SH and 3SHA. The second variant (B) had a one-off addition of 200ppm of Vegecoll added to the juice prior to settling, and had the highest level of 3SH after ageing. On the other hand, 3MHA was higher in variant D, whereby there was a preliminary addition of Vegecoll at 150ppm on the juice prior to settling, plus 30ppm added in alcoholic fermentation. The addition of Vegecoll at 50ppm during alcoholic fermentation alone produces levels of 3SH and 3SHA slightly above the control (A), suggesting the importance of fining in the juice stage. A higher preliminary addition with a subsequent fining had the highest levels of the 3SHA, an acetylated thiol reminiscent of passionfruit. Depending on the style of wine desired, subsequent additions can be beneficial and important for aroma.

ROSÉ

Fining in rosé is crucial as any effect on browning or aroma will be evident. Trials were conducted with a specific combination of PVPP and potato protein (Polymust Rosé®), which stabilises hue and reduces phenolic acids. The synergic effects of PVPP and extract of potato protein can tackle the larger phenolic compounds that form o-quinones, making it ideal for most rosé. Figure 6 demonstrates that different combinations of both pea protein with PVPP (Polymust®V) and potato protein with PVPP (Polymust Rosé) at incrementing levels had a significant effect on colour measured at 420nm, 520nm and 620nm,

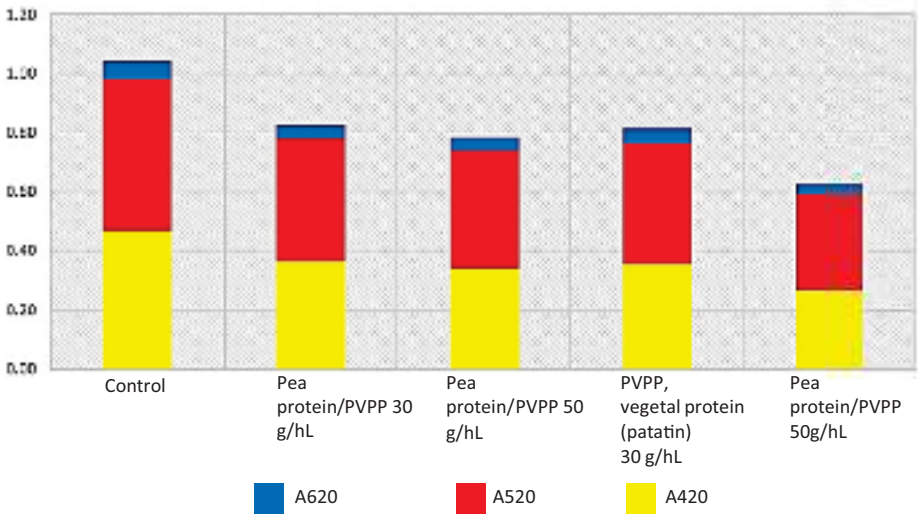

Figure 6. Trials conducted at Cave de Landerrouat 2015, fining on rosé juice.

thereby decreasing the amount that can subsequently oxidise, change colour and neutralise thiols.

WHAT HAPPENS WHEN WINES AREN'T FINED?

With the tendency towards producing a more 'natural' product with minimal intervention, some producers are skipping the fining stage. Aside from possible ramifications with colour and aroma, fining takes away harsh, astringent phenolics which often give the wine a 'phenolic' palate. As discussed previously, fining in the wine is often too late, as the fining agent will have a much harsher impact on desirable compounds. Rosé colour will drop out if there are oxidisable phenolics present that aren't taken out via fining, leading to colour instability in tank and bottle.

CONCLUSIONS

Wine aroma is made up of thiols produced by yeast from precursors in the grapes, esters produces by microbial interaction, grape-derived methoxypyrazines and terpenes which are liberated/volatilised via microbial interaction, chemical or enzymatic hydrolysis. Thiols are highly susceptible to oxidation and important in many white and rosé wines. Fining during fermentation is critical to remove oxidisable phenolics which can bind to thiols produced by yeast to irreversibly remove them. Fining agents and combinations thereof can have a targeted effect on undesirable compounds, and can be tailored to increase certain volatiles depending on the desired wine style. Glutathione will scavenge oxygen in general, and the oxygen on the o-quinone to form a stable compound. It is important to note that if the nutrition in the ferment is not sufficient, glutathione levels will decrease and take away protection from oxidation. Removal of oxidisable phenolics in the juice stage will prevent negative impacts on colour and aroma – when done in the juice stage, higher doses are less likely to strip the wine.

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