Impact of addition of fumaric acid and glutathione at the end of alcoholic fermentation on Cabernet Sauvignon wine

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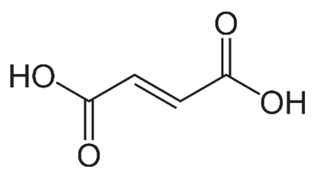
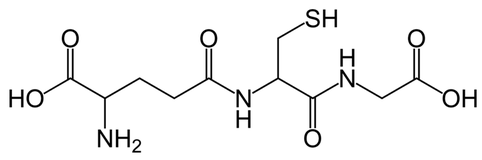
INTRODUCTION

Viticulture and oenology face two major challenges today, climate change and the reduction in the use of inputs. Climate change induces low acidity and microbiologically less stable wines (1), implying more important sulfur dioxide doses to protect wines. This is incompatible with the reduction of inputs. Fumaric acid (FA) is known for its high acidifying power and its bacteriostatic properties (2) and glutathione (GSH) for its antioxidant power (3). FA combined with GSH could solve acidity problems and reduction of sulfur dioxide in wine.

The study aims to evaluate the impact of FA and/or GSH addition at the end of alcoholic fermentation (AF) and just before bottling on wine quality compared to sulfite free, sulfited wine control and tartaric acid (TA) acidified wine. This work only presents the impact of addition of FA and GSH at the end of AF on Cabernet Sauvignon wine.



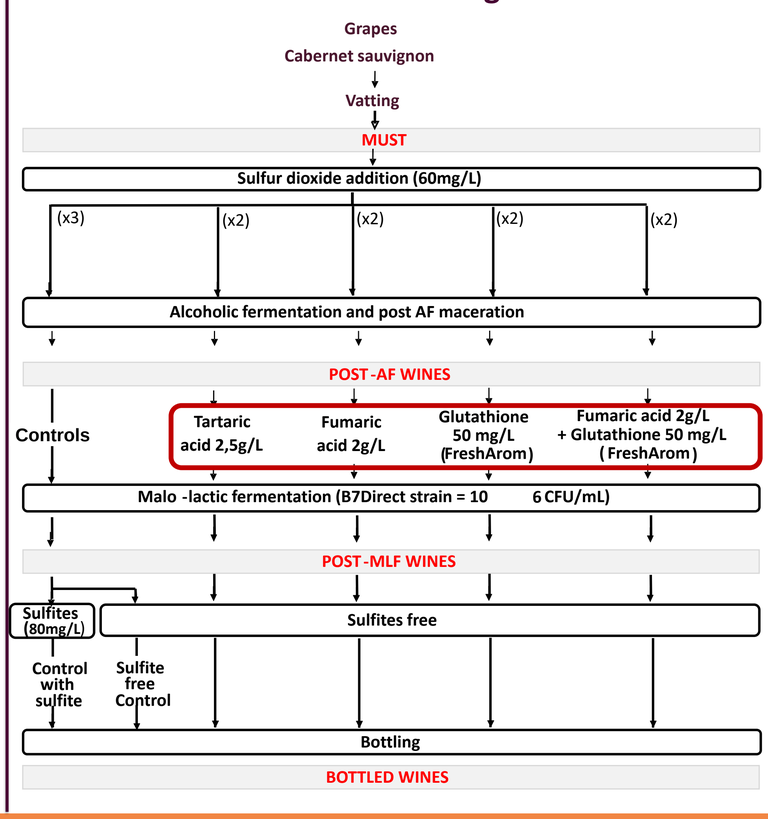
Fumaric acid



Glutathione

MATERIALS & METHODS

Micro-winemakings



Analyses

Sampling
-Post-AF wines
-Post-MLF wines
-3 month-wines

- Malic acid concentration (Y15)
- Lactic acid concentration (Y15)
- pH
- Titratable acidity

Fermentations monitoring

- CIELAB parameters: L*, a*, b*
- Calculation of ΔE

Color

- Total Phenolics Index
- Total Phenolic compounds by Folin-Ciocalteu method
- Total anthocyanins
- Total tannins
- Antioxidant capacities (DPPH, CUPRAC)

Phenolic compounds

- Ranking tests
- Sensory profils

Sensory Impact

RESULTS & DISCUSSION

1. Monitoring of malolactic fermentation

Table 1. Composition of control wine after AF

	Cabernet Sauvignon Control wine before MLF
pH	3.9 ± 0.0
Total acidity (g.L^{-1} H_2SO_4 eq.)	3.6 ± 0.1
Density (g.dm^{-3})	997 ± 0
Alcohol (% v/v)	12.8 ± 0.1
Volatile acidity (g.L^{-1} H_2SO_4 eq.)	0.4 ± 0.0
Tartaric acid (g.L^{-1})	1.8 ± 0.0
Malic acid (g.L^{-1})	1.6 ± 0.0
Lactic acid (g.L^{-1})	0.1 ± 0.0

→ MLF stopped, when already initiated, and delayed by ≈2-3 months when FA (2g/L) was added at the end of AF
→ Higher lactic acid production when 2 g/L FA was added at the end of AF

=> +100% lactic acid compared to the control and TA and GSH treatments

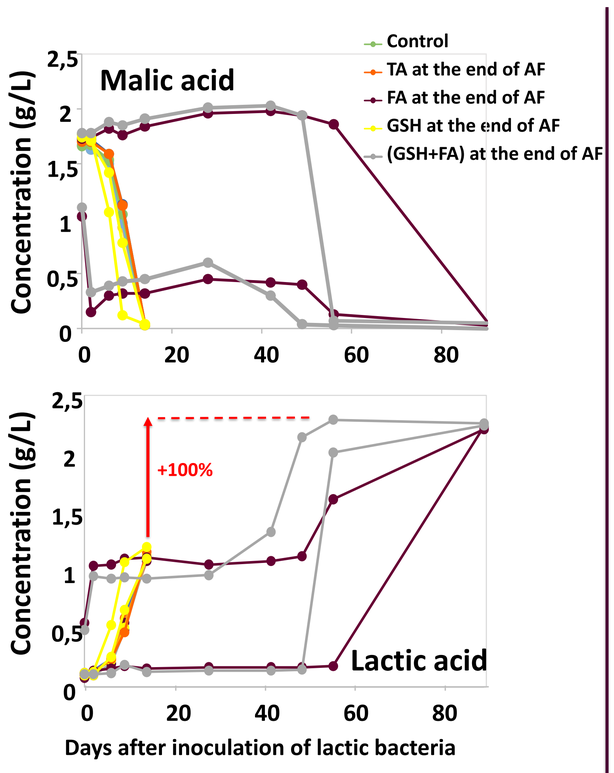


Figure 1. Concentrations of malic and lactic acids during MLF

2. Impact on acidity

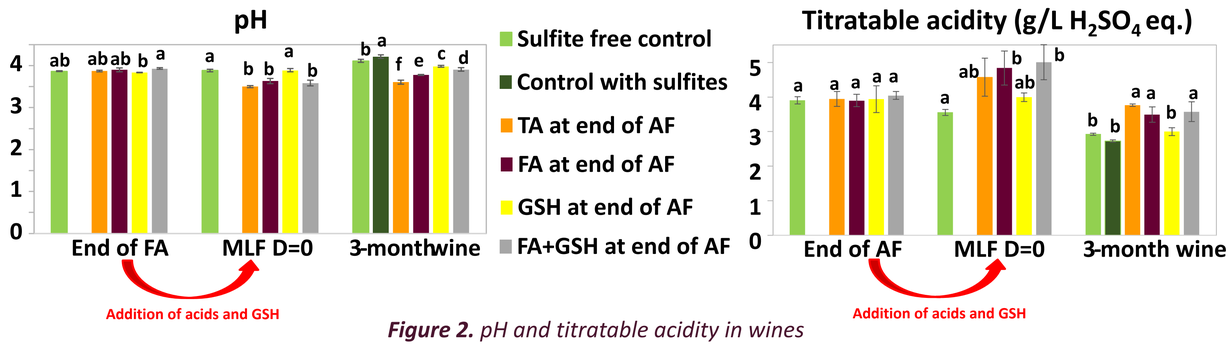


Figure 2. pH and titratable acidity in wines

→ Same decrease of pH and increase of titratable acidity with FA and TA addition
→ pH and titratable acidity differences maintained in the 3-month wines

3. Impact on color

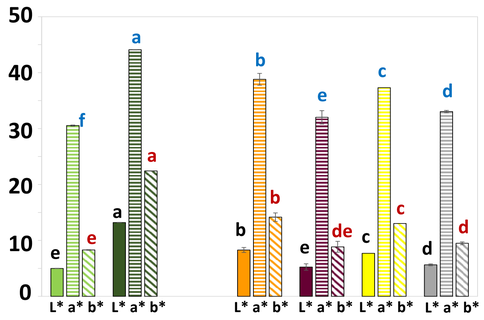


Figure 3. CIELAB parameters in 3-month wines

Table 2. Color difference ΔE between wines

	Free sulfite control	Control with sulfites	TA at the end of AF	FA at the end of AF	GSH at the end of AF
Control with sulfites	21,2	-	-		
TA at the end of AF	10,7	11,0	-		
FA at the end of AF	1,6	19,8	9,1		
GSH at the end of AF	8,7	12,8	2,0	7,2	
GSH + FA at the end of AF	2,8	18,6	7,9	1,3	5,9

→ Color of wines with FA closer to free sulfite control wine
→ Color difference between wines with TA and FA
=> Darker wines with FA addition

4. Impact on phenolic compounds

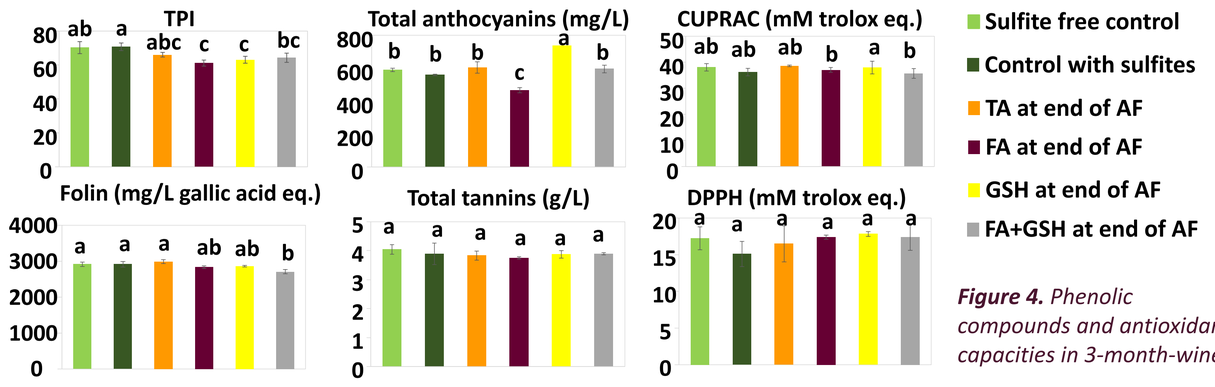


Figure 4. Phenolic compounds and antioxidant capacities in 3-month-wines

→ Slight differences for phenolic compounds in general
→ Differences for total anthocyanins: higher content with GSH addition
=> The addition of GSH had a protection effect on total anthocyanins

5. Impact on sensory quality of 3-month wines

Table 3. Ranking test on « overall quality » of 3-month wines

Control with sulfites	FA+GSH at end of AF	Sulfite free control	GSH at end of AF	TA at end of AF	FA at end of AF	F
56 a	60 a	63 a	63 a	65 a	92 b	12,47

→ Best ranking for wine acidified with FA
→ Wines with AF were perceived as the most acid

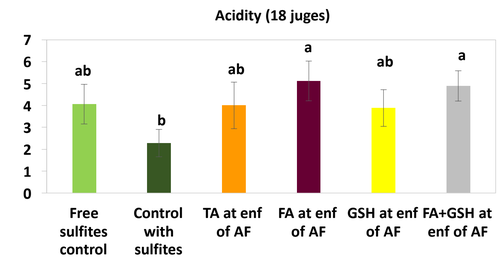


Figure 5. Perceived acidity
(letters = significant difference with α=0,05)

CONCLUSIONS AND PERSPECTIVES

Addition of FA at the end of AF (2.5g/L tartaric acid eq.) provoked the same decrease of pH and the same increase of titratable acidity than the addition of TA (2,5g/L). Moreover, it delayed MLF by 2 to 3 months. When MLF restarted, the production of lactic acid was 100% more important in wines with added FA than in control wine.

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(2) Morata, A.; Bañuelos, M. A.; López, C.; Song, C.; Vejarano, R.; Loira, I.; Palomero, F.; Lepe, J. A. S. Use of Fumaric Acid to Control PH and Inhibit Malolactic Fermentation in Wines. *Food Additives & Contaminants: Part A* **2020**, *37* (2), 228–238. https://doi.org/10.1080/19440049.2019.1684574.
(3) Kritzinger, E. C.; Bauer, F. F.; du Toit, W. J. Role of Glutathione in Winemaking: A Review. *J. Agric. Food Chem.* **2013**, *61* (2), 269–277. https://doi.org/10.1021/jf303665z.