macrowine 2021
Virtual
June 23 - 30

UNIVERSITA' DEGLI STUDI DI NAPOLI FEDERICO II

HOW THE MANAGEMENT OF pH DURING WINEMAKING AFFECTS ACETALDEHYDE EVOLUTION AND THE FORMATION OF POLYMERIC PHENOLICS OVER THE RED WINE AGING

Gambuti A.[a], Picariello L.[a], Rinaldi A.[a, b], Moio L.[a], Forino M.[a]

[a]Department of Agricultural Sciences, Section of Vine and Wine Science, University of Naples 'Federico II', viale Italia, 83100 Avellino, Italy.
[b]Biolaffort, 126 Quai de la Souys, 33100 Bordeaux, France.

Keywords: red wine, aging, pH, polyphenols

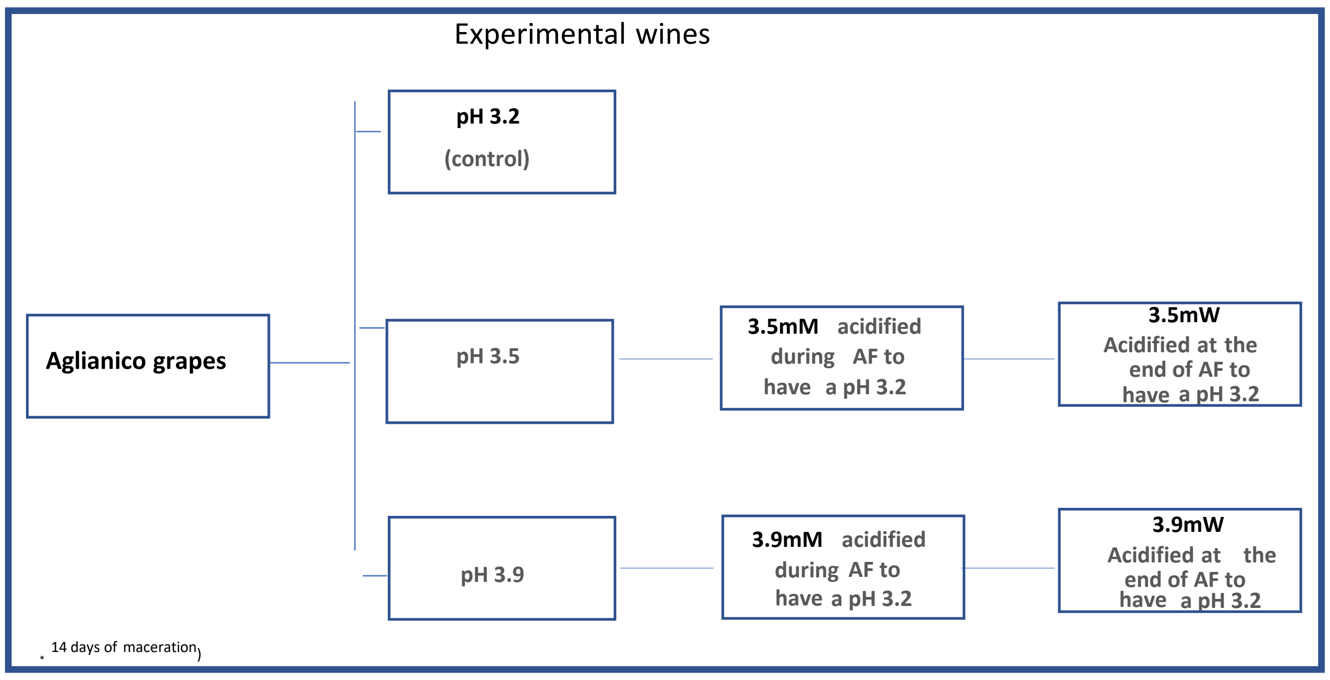
AIM

The aim of this study is to evaluate the role of pH on both the acetaldehyde chemistry and wine phenolics evolution over the aging period. In addition, the effect of both an early (on musts) and late (on wines soon after the end of the fermentation) acidification was evaluated.

MATERIAL AND METHODS

The experimental design consisted in the preparation of 7 wines from the same batch of grapes fermented in a first tank at the original pH of 3.2 (3.2) and two other tanks in which the pH was adjusted to 3.5 (3.5) and 3.7 (3.7). On the third day of fermentation, and one week after the end of the fermentation-maceration process some aliquots of both 3.5 and 3.7 were treated to reach a 3.7 pH to afford four more wines: 3.5 mM, 3.5mW, 3.7mM and 3.7mW. Wines were then filtered at 0.45 μm before aging under controlled oxygen exposure. Polymeric pigments and phenolics were evaluated by spectrophotometry, MS and NMR techniques, acetaldehyde and anthocyanins by HPLC-DAD and reactivity of tannins towards saliva by electrophoresis. Wines were analyzed soon after the end of the fermentation and after one-year aging.

Sampling procedures:
end of alcoholic fermentation
after 1 year of aging
after 2 years of aging
All experiments were carried out in duplicate and two analytical replicas were performed.



RESULTS

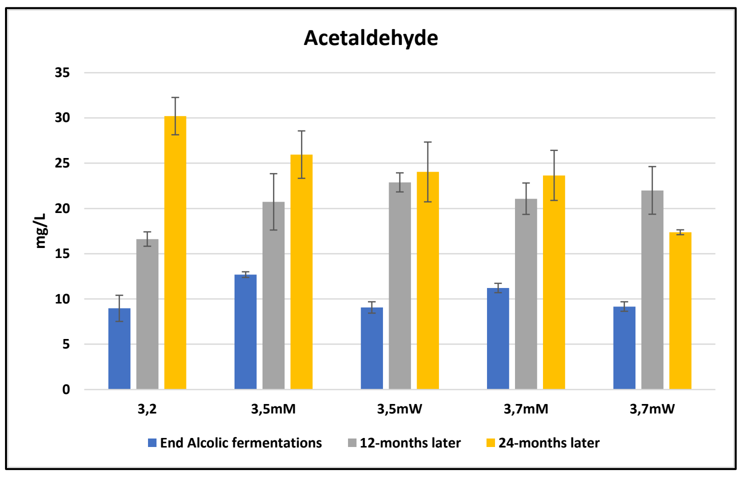


Fig. 1. Evolution of acetaldehyde during aging of experimental wines. 3,2, control wine at pH 3.2; 3,5mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,5mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2; 3,7mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,7mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2.

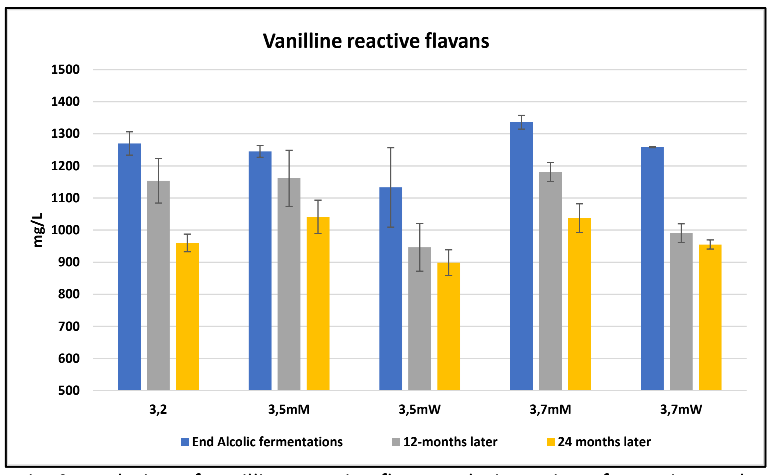


Fig. 2. Evolution of vanilline reactive flavans during aging of experimental wines. 3,2, control wine at pH 3.2; 3,5mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,5mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2; 3,7mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,7mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2;.

The evolution of acetaldehyde is different (Fig. 1). In control wine (pH 3.2), it turned out to increase over two years of aging. Conversely, after the first year of aging a stabilization (pH 3.5 mM, 3.5 mW, 3.9 mM) or even a decrease (pH 3.9 mW) was observed. Probably, this is due to the fact that acetaldehyde, in wines 3.5 mM, 3.5 mW, 3.9 mM and 3.9mW, is quickly consumed by the reactions with flavans (Peterson and Waterhouse, 2016) that were more abundant in wines obtained through a maceration at higher pH values (Forino et al., 2020). Data on the evolution of vanilline reactive flavans supported this hypothesis (Fig. 2).

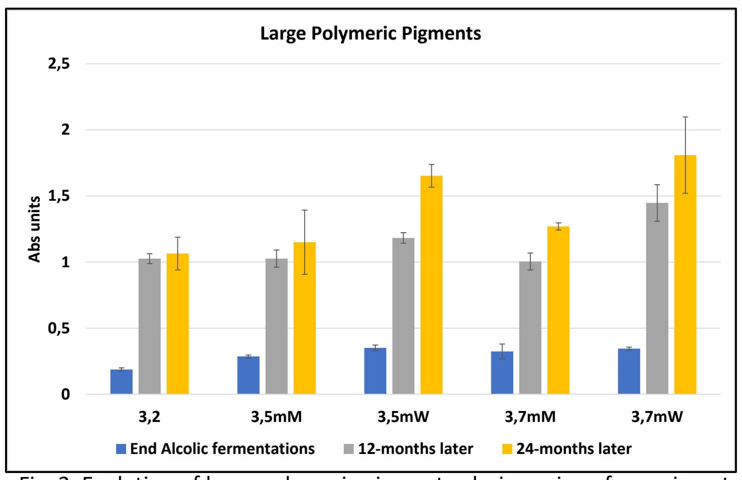


Fig. 3. Evolution of large polymeric pigments during aging of experimental wines. 3,2, control wine at pH 3.2; 3,5mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,5mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2; 3,7mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,7mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2.

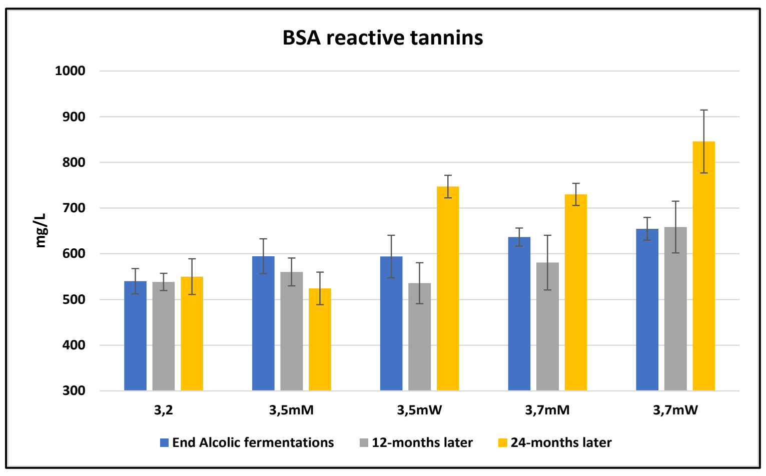


Fig. 4. Evolution of BSA reactive tannins during aging of experimental wines. 3,2, control wine at pH 3.2; 3,5mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,5mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2; 3,7mM, wine originally at pH 3.5 acidified during AF to have pH 3,2; 3,7mW, wine originally at pH 3.5 acidified just after AF to have pH 3,2;

The formation of large polymeric pigments was more massive in wines obtained through maceration of grapes at higher pH (Fig. 3 and Fig. 4). Somehow these pigments balanced the lower amount of native anthocyanins extracted during the maceration at higher pH (Forino et al., 2020), thus contributing to the stability of color intensity of wines over time. Because of during aging a greater formation of Large Polymeric Pigments (LPP) and BSA reactive tannins (generally constituted of structures ranging from trimers to octamers) with respect to short polymeric pigments is usually observed, it is likely that 3.5 mW and 3.9 mW are in an advanced oxidative state than 3.1 wine.

CONCLUSIONS

The maceration of grapes at lower pH favors the extraction of anthocyanins while the increase pH of grapes in this extractive phase determines a higher extraction of flavans. This causes acetaldehyde to behave differently over time even when pH is adjusted at the same low value of 3.2. High pH values, during the first phases of winemaking, favor the polymerization of phenolics over time, although the pH is successively decreased at the same low value of 3.2. Results suggested that the effect is predominant when pH was decreased after the end of fermentation.

REFERENCES: Forino, M.; Gambuti, A.; Luciano, P.; Moio, L. Malvidin-3-*O*-glucoside chemical behavior in the wine pH range. *J. Agric. Food Chem*. **2019**, *67*, 1222-1229.; Kontoudakis, N., González, E., Gil, M., Esteruelas, M., Fort, F., Canals, J. M., & Zamora, F. (2011). Influence of wine pH on changes in color and polyphenol composition induced by micro-oxygenation. *Journal of agricultural and food chemistry*, *59*(5), 1974-1984.; Setford, P. C., Jeffery, D. W., Grbin, P. R., & Muhlack, R. A. (2017). Factors affecting extraction and evolution of phenolic compounds during red wine maceration and the role of process modelling. *Trends in Food Science & Technology*, *69*, 106-117. Peterson, A. L., & Waterhouse, A. L. (2016). 1H NMR: a novel approach to determining the thermodynamic properties of acetaldehyde condensation reactions with glycerol,(+)-catechin, and glutathione in model wine. Journal of agricultural and food chemistry, 64(36), 6869-6878.