KEYNOTE LECTURE

The problem of the increasing pH in sparkling wines caused by climate change: use of cationic exchange to correct it

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INTRODUCTION

In recent years, the increase in temperature and the changes in rainfall distribution caused by climate change are affecting vine and grape physiology and are consequently impacting wine composition and quality (Schultz, 2000; Jones et al., 2005). As a consequence of global warming, the grape pulp ripens faster, and the pH and sugar concentration become too high and titratable acidity too low (Schultz, 2016). Therefore, grapes reach a very high potential alcoholic degree and pH sooner than usual. This phenomenon causes harvest dates to be earlier and makes it much more difficult to pinpoint proper aromatic and pulp maturity, which leads to unbalanced wines (Zamora, 2014). The increase on the pH is especially problematic in sparkling wines because they need higher acidity to maintain an adequate freshness.

In this new scenario, oenologists are looking for strategies to mitigate these effects. There seems to be only two possibilities: they can harvest when alcoholic degree and pH are at the correct level and accept that the grapes will not have the correct aromatic and phenolic maturity; or they can wait for adequate maturity and accept that the wines will have high ethanol content and pH.

Neither of these choices is conducive to obtain high quality wines and therefore winemakers are obviously concerned about this problem. Since the lack of real grape maturity cannot be compensated for, most winemakers prefer to wait for the correct grape maturity and then later apply procedures to compensate for the disequilibrium of these unbalanced grapes (Zamora, 2014).

Several practices for reducing sugar in grape juice or ethanol in wines have been proposed (Zamora, 2016). More problematic is compensating titratable acidity and pH. The problem of the low titratable acidity of grape juices and wines can be easily solved by adding authorised acids. Nevertheless, all these organic are not efficient enough for lowering the pH. Furthermore, the use of mineral acids is strictly forbidden (OIV, 2021). In fact, there are only two techniques authorised by OIV for reducing pH: electrodialysis and cationic exchange. Both techniques are very effective and are being increasingly used by wineries; however, cation exchange is probably being more widely used due to its lower cost (Lasanta and Gómez, 2012).

Several studies have been reported about the use of cationic exchange in grape juice and wine and its effects on wine composition and quality but only few of them refer to base wines and only one of them have focused on the effect on sparkling wines produced using the traditional method (Just-Borras et al., 2022). Therefore, the aim of this work is to study how applying cationic exchange to the grape juice influences the composition and quality of the base wines and their corresponding sparkling wines.

RESEARCH OBJECTIVES

As previously mentioned, due to the limited information on the use of cation exchange in sparkling wine production, this study aimed to examine its influence on the physicochemical composition and overall quality of sparkling wines.

MATERIAL AND METHODS

Around 2,000 L of Macabeo must was divided equally into two parts: one underwent cation exchange using a cation exchange column (FreeK+ column, Agrovin, Ciudad Real, Spain) and the other did not undergo any treatment. Subsequently, the two musts were blended together in different proportions (0, 5, 10, 15, 20, 25, 35 and 45 % of treated must) in order to obtain a set of grape musts with different pHs. All the different blends were used for making base wines by microvinification. After stabilisation, these base wines were used for producing sparkling wine using

a traditional method. Eleven and twenty months later, the bottles were disgorged and their contents used for analysis.

Analytical methods recommended by the OIV (2019) were used to determine ethanol, residual sugar, pH, titratable acidity and the different acids. The potassium concentration was determined by FAES (Aceto et al., 2002). Proteins were measured by HRSEC-DAD, polysaccharides by HRSEC-RID and the foaming properties by Mosalux technique (Just-Borras et al., 2022).

A sensory analysis was performed by a trained panel. The tasters were required to evaluate the intensity of 6 attributes (Colour, Balance Reduction/Oxidation, CO2 integration, Structure, Acidity and Global quality) on a scale of 1 to 10.

RESULTS

Figure 1 shows the effect of cationic exchange treatment on the pH (A) and titratable acidity (B) of the must, base wine and corresponding sparkling wines after 11 and 20 months of ageing. The results show that the pH of the grape must decrease significantly as the proportion of treated must in the blend increases whereas titratable acidity does the opposite. Both trends were maintained in the base wine and in both sparkling wines. These results agree with previous published results (Ibeas et al., 2015).

Figure 2 shows the influence of cation exchange treatment on potassium concentration of base wine. As expected, the potassium concentration decreased progressively as the proportion of treated must in the blend increased. These data confirm the effectiveness of cationic exchange treatment for removing this cation from wines and that it is precisely this potassium depletion that causes the pH to decrease.

No significant differences were found due to the effect of the cation exchange treatment in the content of ethanol and residual sugars, or in any of the following acids: L-malic, L-lactic, acetic, succinic and citric. It was only observed that tartaric acid concentration increased progressively as the proportion of treated grape must in the blend increased. This behaviour can be explained because the lower the potassium concentration the lower the crystallisation of potassium hydrogen tartrate in the wine.

The concentrations of proteins and polysaccharides were not significantly affected by cation exchange which indicates that this treatment does not alter the colloidal wine composition. This is a very interesting result, because polysaccharides (mannoproteins) and especially proteins have been described as being foam stabilisers in sparkling wines. Almost all wine proteins have a positive charge at wine pH since their isoelectric point is higher than the wine pH. Therefore, it would be reasonable to assume that cation exchange resins can retain part of these proteins. However, according to our results, cationic exchange does not remove them.

With regard to the properties of the foam, no notable differences were observed due to the effect of the cation exchange treatment, neither in the base wine nor in the sparkling wine of 11 months. However, a significant decrease in the foam parameters (maximal height - HM and stable height – HS) was observed in sparkling wines aged 20 months, but only when the proportion of treated must in the blend was very important. This data therefore indicate that the cationic exchange treatment of the grape juice does not affect the foaming properties of the base wine and young sparkling wines, but that it can negatively affect the foaming characteristics of older sparkling wines, especially when the proportion of treated must is very high.

The sparkling wines of 20 months of ageing were tasted by a trained panel. The only sensory attribute in which the trained panel found clear differences was the acidity with no differences detected in any of the other descriptors. The panel also considered that the sparkling wine gained in freshness when the proportion of the treated grape must in the blend was not too high. However, the acidity of the sparkling wines with a very high proportion of treated grape must was considered excessive. The fact that the panel did not find any differences in the other sensory attributes indicates that the cation exchange treatment of the must does not exert a negative sensory effect on the final sparkling wine quality.

CONCLUSION

It can therefore be concluded that applying cationic exchange treatment to the must is a very useful tool for reducing the pH of sparkling wines and increasing their freshness. In addition, this treatment is really economic since, according to the manufacturer's data, it has an estimated cost of only 0.25 euros/hL. However, the fact that excessive treatment can damage the acidity balance and negatively affect the quality of the sparkling wine should be taken into account.

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REFERENCES

Aceto, M., Abollino, O., Bruzzoniti, M. C., Mentasti, E., Sarzanini, C., & Malandrino, M. (2002). Determination of metals in wine with atomic spectroscopy (flame-AAS, GF-AAS and ICP-AES); a review. Food Additives and Contaminants, 19(2), 126–133. https:// doi.org/10.1080/02652030110071336

Ibeas, V., Correia, A. C., & Jordão, A. M. (2015). Wine tartrate stabilization by different levels of cation exchange resin treatments: Impact on chemical composition, phenolic profile and organolèptic properties of red wines. Food Research International, 69, 364–372. https://doi.org/10.1016/j.foodres.2015.01.003

Jones, G. V., White, M. A., Cooper, O. R., & Storchmann, K. (2005). Climate change and global wine quality. *Climatic Change*, 73(3), 319–343. https://doi.org/10.1007/s10584-005-4704-2

Just-Borras, A., Pons-Mercadé, P., Gombau, J., Giménez, P., Vilomara, G., Conde, M., Cantos, A., Canals, J.M., & Zamora, F. (2022). Effects of using cationic exchange for reducing pH on the quality and composition of sparkling wine (Cava). Oeno One, 56, 179-192. https://doi.org/10.20870/oeno-one.2022.56.2.5399

Lasanta, C., & Gómez, J. (2012). Tartrate stabilization of wines. *Trends in Food Science and Technology*, 28(1), 52–59. https://doi. org/10.1016/j.tifs.2012.06.005

OIV (2019). «Compendium of International Methods of Wine and Must Analysis» volume 2.

OIV (2021). International code of oenological practices (OIV, Vol. 33). Paris, France

Schultz, H. R. (2000). Climate change and viticulture: A European perspective on climatology, carbon dioxide and UV-B effects. *Australian Journal of Grape and Wine Research*, 6(1), 2–12. https:// doi.org/10.1111/j.1755-0238.2000.tb00156.x

Schultz, H. R. (2016). Global Climate Change, Sustainability, and Some Challenges for Grape and Wine Production. *Journal of Wine Economics*, 11(1), 181–200. https://doi.org/10.1017/jwe.2015.31

Zamora, F. (2014). Adapting red winemaking to climate change conditions. *Journal International des Sciences de la Vigne et du Vin*, Spécial issue on the Laccava project, 69-75.

Zamora, F. (2016). Delacoholised Wines and Low-Alcohol Wines. In M. V. Moreno-Arribas & B. Polo-Sualdea (Eds.), Wine Safety, Consumer Preference, and Human Health (pp. 163–182). New York, USA: Springer. https://doi.org/10.1007/978-3-319-24514-0_8

FIGURES

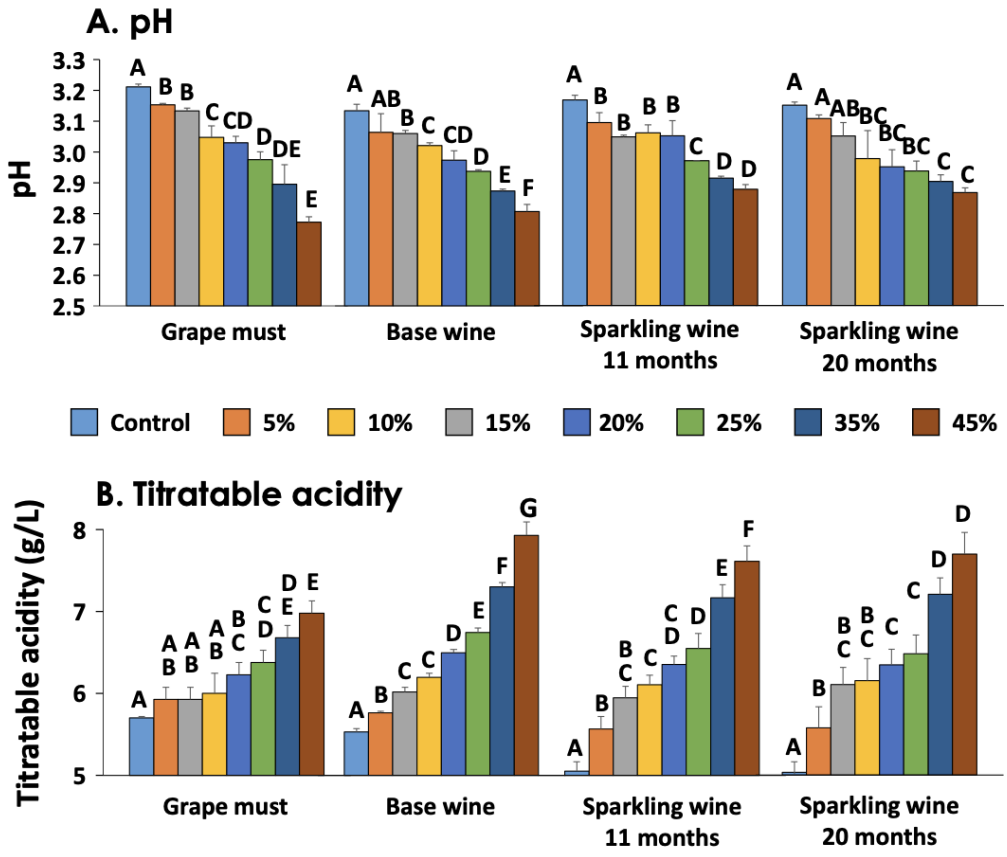

Figure 1. Influence of cation exchange treatment on pH and titratable acidity.

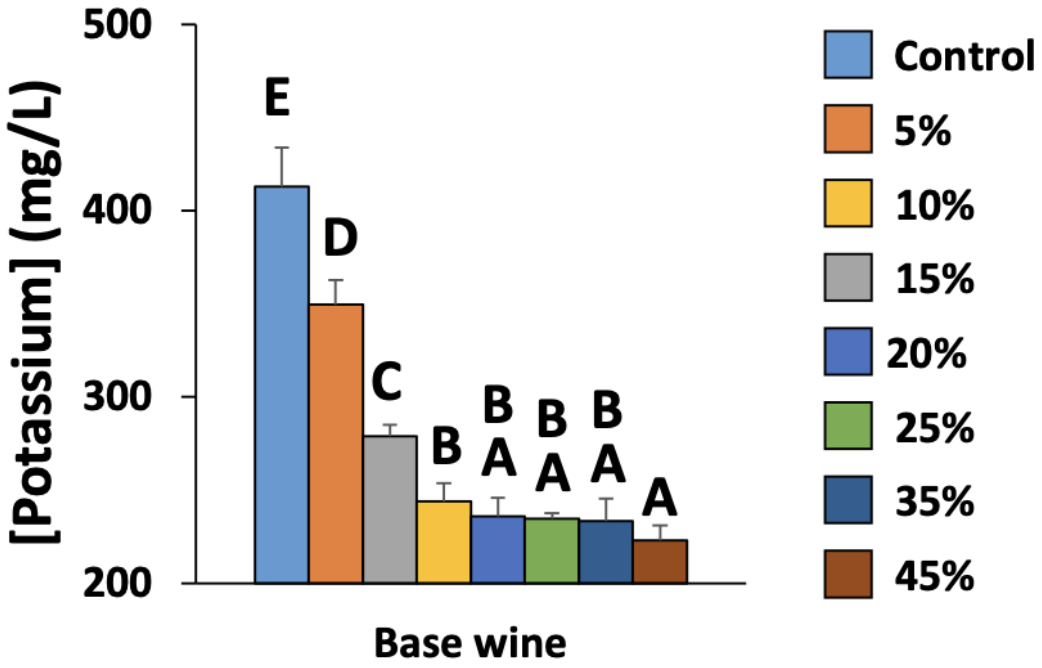

Figure 2. Influence of cation exchange treatment on potassium content of the base wine.