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Foliar kaolin residues in grapes and its influence on the alcoholic fermentation process

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INTRODUCTION

Climate change has a negative effect on crop yields, significantly affecting Mediterranean vineyards. The incidence of new pests and increasingly extreme weather conditions, particularly temperature, makes it necessary to search for adaptation measures, especially in the more arid viticultural areas. The use of kaolin applied to the vegetation may be a promising agronomic technique due to its ability to reflect incident radiation. Moreover, kaolin can interfere with insect development and behaviour on the crop, and its use as an alternative tool for pest control has increased in recent years. However, little is known about the potential accumulation of kaolin-derived residues in grapes and wines or their effect on alcoholic fermentation. This study evaluates the impact of kaolin particle film on aluminium (Al) residues and fermentation.

METHODOLOGY

Kaolin treatments were applied with a backpack sprayer at constant pressure in a randomized block design, using experimental units of 16 vines, in three vineyard zones in Valencia, Spain, from 2023 to 2025. Five treatments were evaluated: control and four kaolin programmes combining 5–10% (w/v) and one or two applications at pre- and/or post-veraison. At harvest, grape samples were collected and must was obtained to quantify aluminium (Al) and other metals by ICP-OES. The same grapes were then vinified by experimental microvinification, and metal residues were also analysed in the resulting wines.

Fermentation kinetics were assessed in Tempranillo and Monastrell musts from Control and T4 grapes (Table 1), using four commercial *Saccharomyces* yeast strains. Fermentation was monitored by weight loss and modelled with a reparametrized Gompertz equation. Final metabolites were analysed by HPLC and GC.

RESULTS

Table 1. Experimental sites and kaolin treatment programmes used for metal composition analysis, showing wine region, grape variety, treatment, dose, number of applications and vintage.

Vineyard	Grape variety	Treatment	Dose	Nº treatments	Year
Moncada	Monastrell	Control	-	-	2023
Moncada	Monastrell	T2	5%	2	2023
Moncada	Monastrell	Control	-	-	2023
Moncada	Monastrell	T2	5%	2	2023
Moncada	Monastrell	Control	-	-	2024
Moncada	Monastrell	T2	5%	2	2024
Moncada	Monastrell	Control	-	-	2024
Moncada	Monastrell	T2	5%	2	2024
Moncada	Monastrell	Control	-	-	2025
Moncada	Monastrell	T2	5%	2	2025
Moncada	Monastrell	Control	-	-	2025
Moncada	Monastrell	T2	5%	2	2025
Turís	Garnacha	Control	-	-	2023
Turís	Garnacha	T2	5%	2	2023
Turís	Moscatel	Control	-	-	2025
Turís	Moscatel	T1	5%	1	2025
Turís	Moscatel	T2	5%	2	2025
Turís	Moscatel	T3	10%	1	2025
Turís	Moscatel	T4	10%	2	2025
Fontanars dels Alforins	Marselán	Control	-	-	2024
Fontanars dels Alforins	Marselán	T4	10%	2	2024
Fontanars dels Alforins	Chardonnay	Control	-	-	2024
Fontanars dels Alforins	Chardonnay	T1	5%	1	2024
Fontanars dels Alforins	Chardonnay	T2	5%	2	2024
Fontanars dels Alforins	Chardonnay	T3	10%	1	2024
Fontanars dels Alforins	Chardonnay	T4	10%	2	2024
Fontanars dels Alforins	Tempranillo	Control	-	-	2024
Fontanars dels Alforins	Tempranillo	T1	5%	1	2024
Fontanars dels Alforins	Tempranillo	T2	5%	2	2024
Fontanars dels Alforins	Tempranillo	T3	10%	1	2024
Fontanars dels Alforins	Tempranillo	T4	10%	2	2024
Fontanars dels Alforins	Monastrell	Control	-	-	2024
Fontanars dels Alforins	Monastrell	T1	5%	1	2024
Fontanars dels Alforins	Monastrell	T2	5%	2	2024
Fontanars dels Alforins	Monastrell	T3	10%	1	2024
Fontanars dels Alforins	Monastrell	T4	10%	2	2024
Fontanars dels Alforins	Chardonnay	Control	-	-	2025
Fontanars dels Alforins	Chardonnay	T1	5%	1	2025
Fontanars dels Alforins	Chardonnay	T2	5%	2	2025
Fontanars dels Alforins	Chardonnay	T3	10%	1	2025
Fontanars dels Alforins	Chardonnay	T4	10%	2	2025
Fontanars dels Alforins	Marselán	Control	-	-	2025
Fontanars dels Alforins	Marselán	T1	5%	1	2025
Fontanars dels Alforins	Marselán	T2	5%	2	2025
Fontanars dels Alforins	Marselán	T3	10%	1	2025
Fontanars dels Alforins	Marselán	T4	10%	2	2025
Fontanars dels Alforins	Monastrell	Control	-	-	2025
Fontanars dels Alforins	Monastrell	T1	5%	1	2025
Fontanars dels Alforins	Monastrell	T2	5%	2	2025
Fontanars dels Alforins	Monastrell	T3	10%	1	2025
Fontanars dels Alforins	Monastrell	T4	10%	2	2025

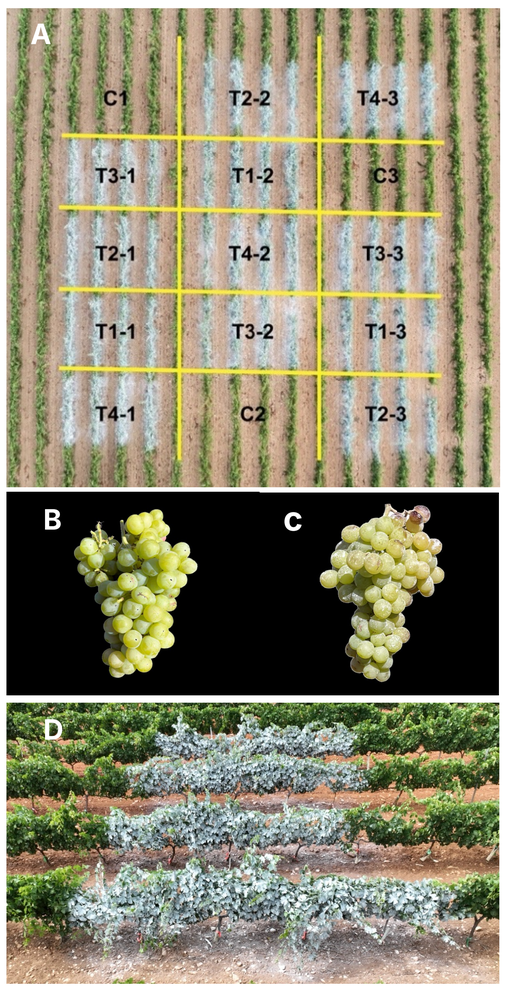

Fig 1. Treatment distribution in the experimental vinyard (A), Moscatel grapes at harvest time. Control (B) and T4 treated with two applications of kaolin at 10% w/v (C) and Tempranillo vines right after an application of kaolin at 10% (w/v) (D).

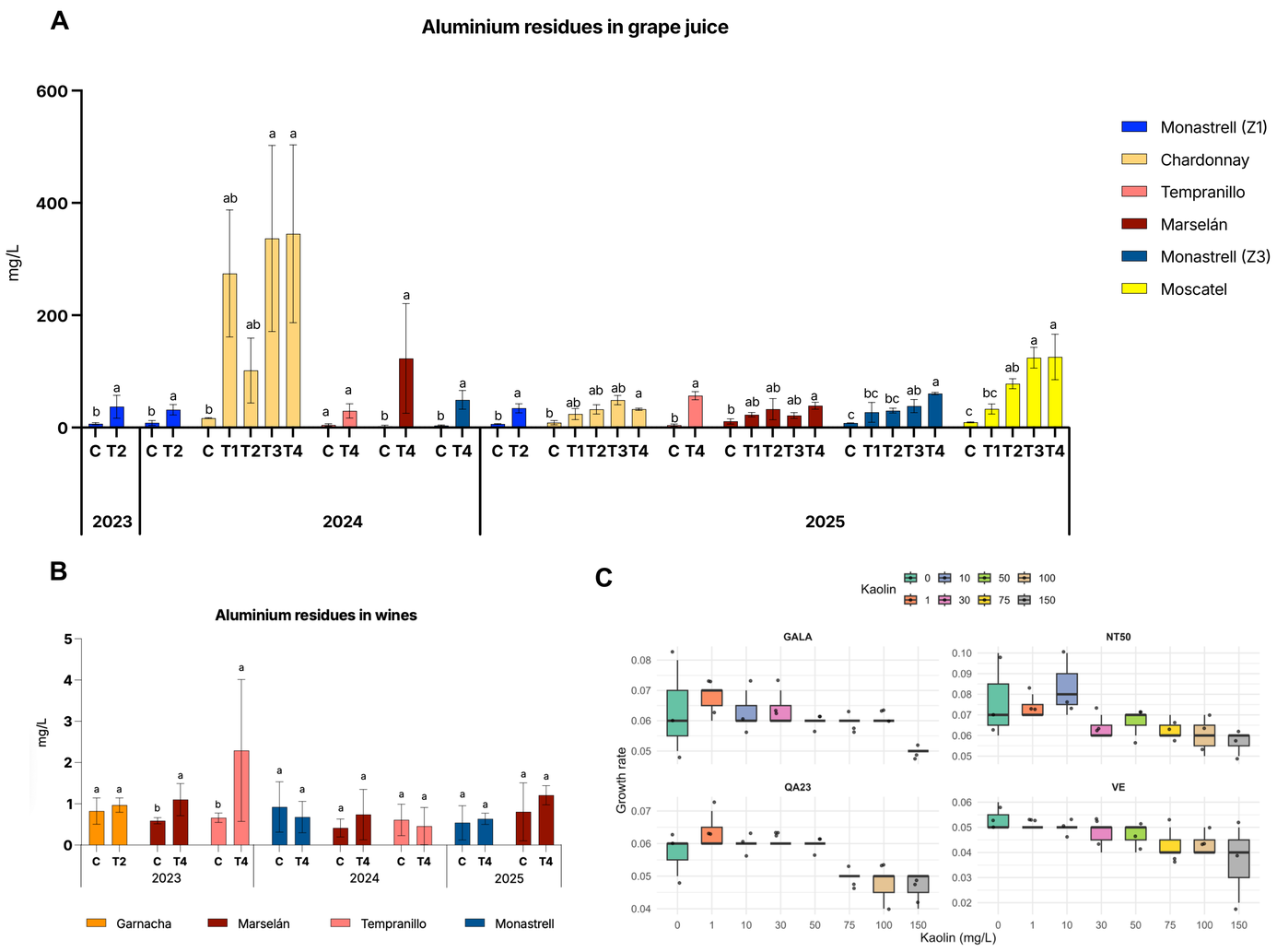

Fig 2. Al content in grape juice (A) and in final wines (B) with four kaolin treatments: Control, T1 (one post-veraison treatment at 5%), T2 (two treatments at 5% pre- and post- veraison), T3 (one post-veraison treatment at 10%), T4 (two treatments at 10% pre- and post- veraison) and yeast strains growth rate at different kaolin concentration (C)

Kaolin residues remained visible on Moscatel grapes and vine surfaces 44 days after application, confirming the high persistence of the particle film under low-rainfall conditions. This persistence was reflected in grape juice composition, where kaolin-treated grapes showed 4 to 50 fold higher aluminium (Al) concentrations than controls, exceeding 400 mg/L in some varieties. During winemaking, Al decreased sharply from an average of 60.32 mg/L in juices from kaolin-treated grapes to 0.62 mg/L in the corresponding wines. Most wines remained below 2 mg/L, with a maximum value of 4.34 mg/L. All yeast strains tested completed alcoholic fermentation in the presence of kaolin. Although high kaolin concentrations slightly reduced yeast growth rate in some strains, no complete inhibition or stuck fermentation was observed, and the final metabolite profile was not significantly affected.

CONCLUSIONS

Foliar kaolin applications can leave persistent residues on grape berries and substantially increase Al concentration in grape juice. However, Al residues are strongly reduced during winemaking, resulting in final wines with low Al concentrations and values below the OIV limit. Kaolin did not compromise alcoholic fermentation or the final metabolite composition of wines, supporting its use in grapes intended for vinification. Al residues should be considered when kaolin-treated grapes are destined for fresh consumption, grape juice or other non-fermented grape products.

REFERENCES

Conde, A. et al. (2018). Kaolin particle film application stimulates photoassimilate synthesis and modifies the primary metabolome of grape leaves. Journal of Plant Physiology, 223, 47–56.

Dinis, L.-T. et al. (2020). Overview of kaolin outcomes from vine to wine: Cerceal white variety case study. Agronomy, 10, 1422.

Linder, C. et al. (2020). Efficacy of kaolin treatments against Drosophila suzukii and their impact on wine composition and taste. Vitis, 59, 49–52.

Castiñeira Gómez, M.M. et al. (2004). Changes of the metal composition in German white wines through the winemaking process. Food Additives and Contaminants, 21, 109–122.

Tariba, B. (2011). Metals in wine—impact on wine quality and health outcomes. Biological Trace Element Research, 144, 143–156.

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