

Evaluation of intrinsic grape berry and cluster traits for postharvest withering kinetics prediction

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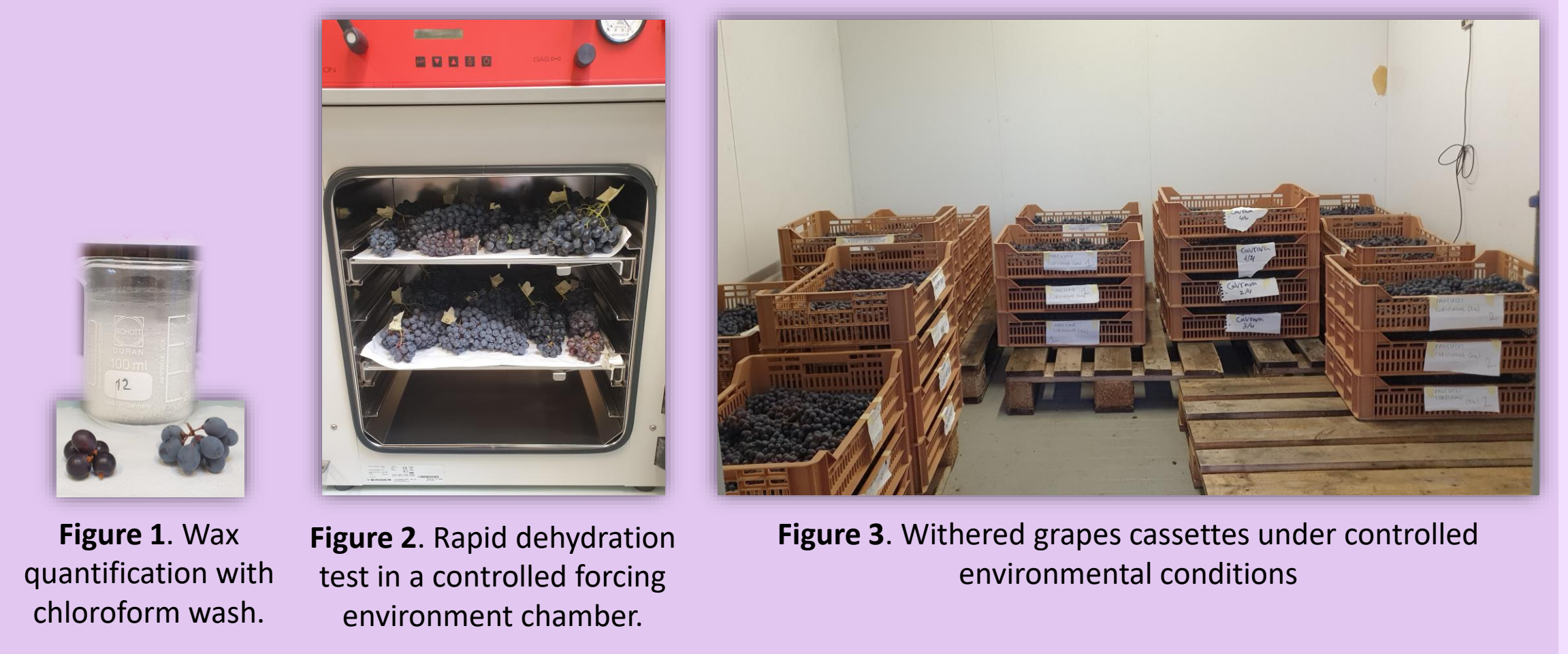
Introduction

To make some particular wine styles (e.g., Amarone), grapes may be harvested and stored in dehydrating rooms before vinification, in a process called withering (1). During withering physical, chemical and metabolic changes are occurring in the berries and determine the quality of the produced wine (2). Previous investigations provided evidence for a positive correlation between the slow rate of dehydration and the intensity of these changes (3). Along with the temperature and relative humidity conditions during withering, the physical/morphological parameters of the grapes have an important role in the determination of the grape water loss rate (4,5). The aim of this work was to investigate the relative contribution of each cluster/berry physical trait to the dehydration rate and the possibility to predict the latter parameter in advance.

Methodology

Four red wine grape cultivars, Corvina, Corvinone, Cabernet Sauvignon (CS) and Cavrara, were harvested at commercial ripening and their cluster compactness, berry surface area to volume ratio, skin thickness and skin waxes quantity (Fig 1) were measured. Furthermore, a novel rapid dehydration test in a controlled forcing environment oven (50 °C; 400 mbar; 24 h) was applied on grape clusters to assess their intrinsic tendency to loss water (Fig 2). The grapes were then withered for 77 days, under controlled environmental conditions

simulating the commercial process (11.63 ± 0.58 °C ; 70.39 ± 2.63 % RH; Fig 3) and the dehydration kinetic rates were obtained. Dehydration index was calculated to evaluate the sugar concentration relatively to the WL. Multivariate and correlation analyses were employed to search and score the relation between each measured parameter and the withering kinetic rate.



Results

Cluster and berry physical/morphological parameters

The cvs show remarkable differences in most of the morphological parameters measured. CS has significantly less compact cluster and present the highest S/V ratio (Fig 4A and B). Corvinone berries present a significant thicker skin compare to the other cvs, followed by Corvina (Fig 4C). From the wax to surface ratios clear statements can not be done (Fig 4D). The WL rates obtained from the rapid dehydration in the oven (Fig 4E) are only partially consistent with the WL rates during withering (Fig 4F).

Multivariate and correlation analyses

The PCA yield a remarkable separation of the cvs (Fig 5A). CS and Cavrara are found in the positive direction of Dim1, along with the two dehydration parameters the WL rates and WL oven, and the S/V ratio morphological parameter. Conversely, the cluster compactness and the skin thickness parameters have negative loadings on Dim1 and are more associated with lots of Corvina and Corvinone. Correlation analyses between the different parameters and the WL rates confirm strong significant correlation of the withering kinetics with the skin thickness, berry surface area to volume ratio and cluster compactness, hence, these parameters can be considered as good predictors of the grapes water loss attitude (Fig 5B).

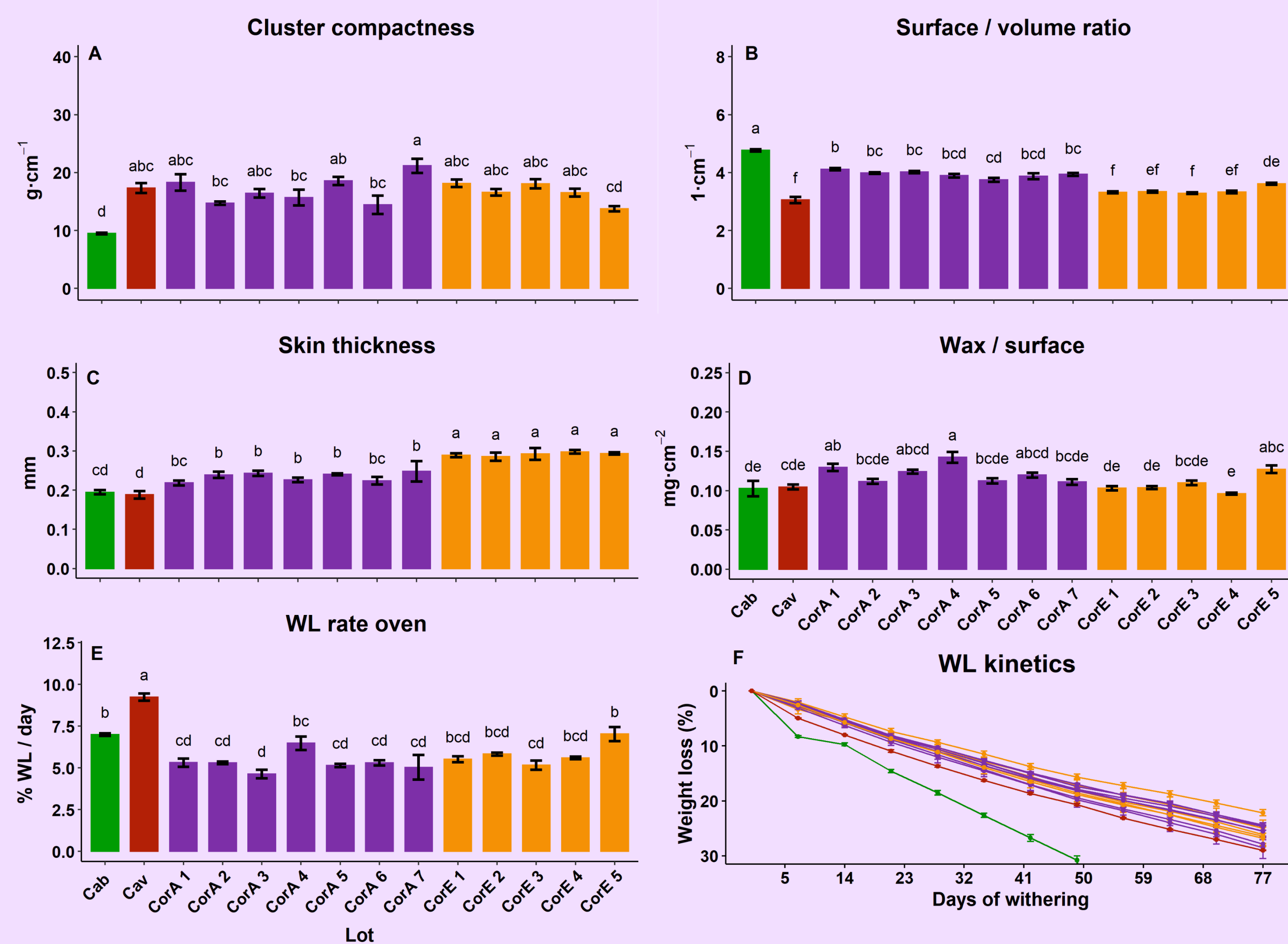


Figure 4. Cluster and berry physical morphological parameters and withering kinetics measured in grapes sampled from 14 different lots of CS (green), Cavrara (red), Corvina (purple) and Corvinone (orange). Each data represents the average (\pm SD) of three biological replicates. Lowercase letters indicate statistically significant differences at $p \leq 0.05$ according to the results of a Tukey's HSD test, applied after one-way ANOVA test.

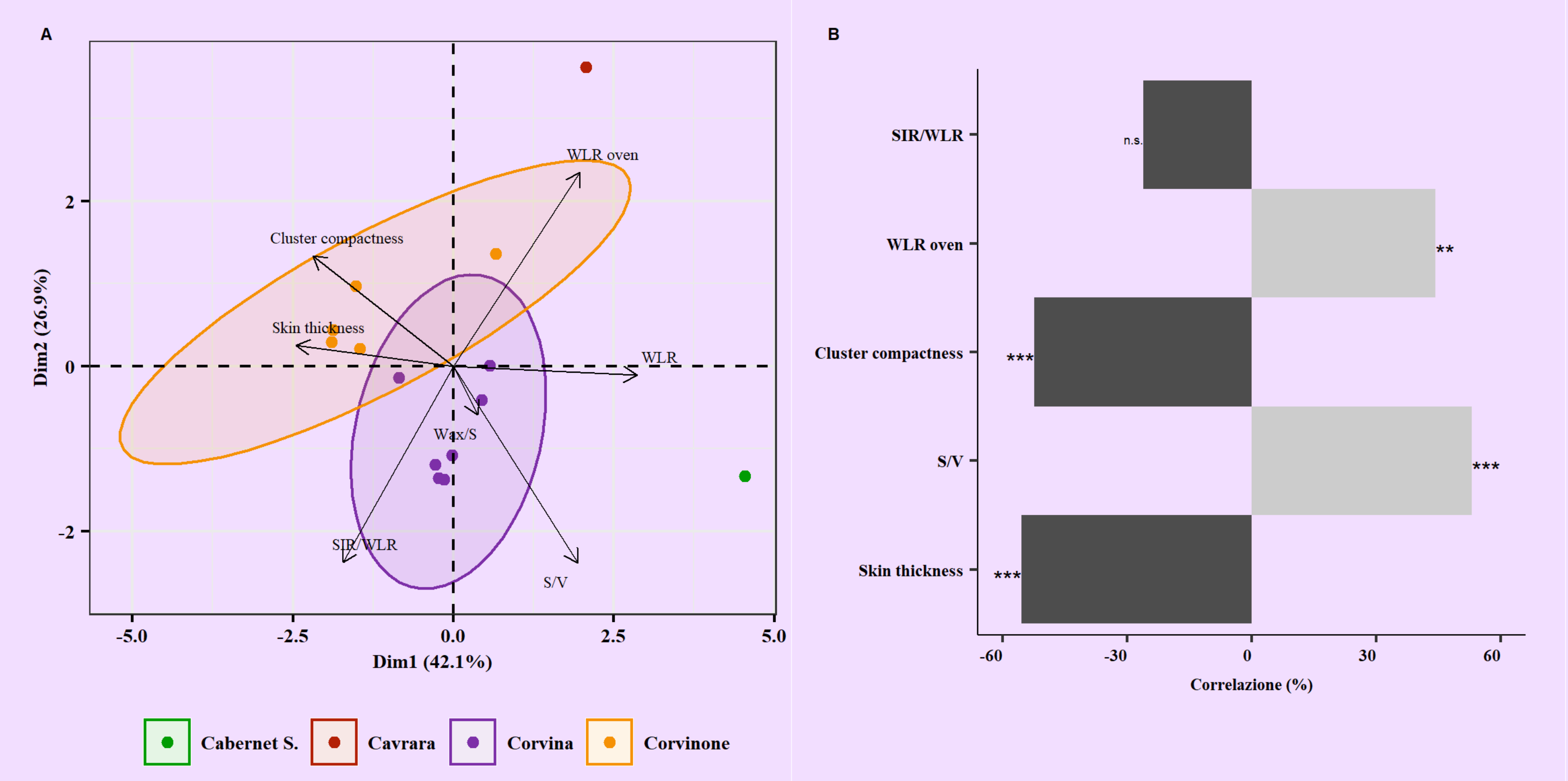


Figure 5. A. Principal component analysis (PCA) biplot of 14 lots tested of CS (green), Cavrara (red), Corvina (purple) and Corvinone (orange) and 7 predictor variables (arrows) measured in grapes before, during and after withering. B. Positive (light gray) and negative (dark gray) Pearson's correlations between variables measured in grapes before, during and after withering against the withering kinetic rates. Only correlations above 20% are presented. Asterisks indicate significant correlations (t-test; $p \leq 0.05$, *, $p \leq 0.01$; **, $p \leq 0.001$, ***) while "n.s." indicates non-significant difference.

WLR: weight loss rate; **S/V:** berry surface to volume ratio; **Wax/S:** berry wax quantity to surface; **SIR/WLR:** sugar content increase rate to weight loss rate during withering.

Conclusion

- Many parameters affect the withering kinetics, presenting different relative contributions to the water loss rate.
- Physical/morphological parameter analyses of four different grape wine cultivars pointed out the skin thickness, berry surface area to volume ratio and cluster compactness as good predictors of the grapes water loss attitude.
- Intra-cultivar analyses performed on Corvina and Corvinone separately have not identified parameters with significant correlations to the withering kinetic rate, likely because of the very low variability observed among accessions of the same cultivar.

References

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