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THE INFLUENCE OF SELECTED YEAST STRAINS ON THE QUALITY OF WINE FROM THE "CABERNET SAUVIGNON" VARIETY

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ABSTRACT
Yeast plays a crucial role in the winemaking process. The primary function of selected yeast strains is to ensure a rapid, complete, and efficient conversion of grape sugars into ethanol, during which specific aromatic precursors are transformed into a wide range of volatile compounds, accompanied by the release of carbon dioxide. The choice of yeast significantly influences the organoleptic profile of wine. Today, numerous commercially available wine yeast strains enable winemakers to tailor wines to different consumer markets. This study evaluated the impact of three different yeast strains on the fermentation of Cabernet Sauvignon must, focusing on the chemical composition, phenolic content, and sensory properties of the resulting wines. The results demonstrated that yeast selection significantly affected key compositional parameters, including tannins and polyphenol levels. Under identical vinification conditions, the "VRB" strain produced wines with the highest color intensity and total polyphenol content, contributing to enhanced sulfur stability and preservation of primary aromas. The "Clos" strain proved the greatest fermentation robustness, resulting in the highest alcohol content while maintaining total acidity, which is essential for freshness and structural balance. Sensory evaluation revealed that the "Clos" strain enhanced varietal typicity, especially fruity-spicy notes; the "D-254" strain produced wines with medium body and pronounced fruity aromas; whereas the "VRB" strain improved body and polyphenol structure, indicating greater aging potential.

Keywords: wine, fermentation, selected yeasts, chemical composition, sensory properties.

INTRODUCTION

The use of different yeast strains in winemaking aims to achieve a consistent and desired wine style by producing a diverse range of volatile compounds (Howell et al., 2006). However, the use of commercial yeast strains may sometimes reduce the uniqueness of a wine's aroma profile (Alves et al., 2015), as each strain produces a specific set of metabolites.

The role of yeast in winemaking has been extensively studied. Numerous studies have shown that different strains result in distinct fermentation outcomes and are capable of reaching high cell densities comparable to those of *Saccharomyces cerevisiae* (10^6–10^8 cells/mL) (Fleet et al., 1984). Zironi et al. (1993) emphasized the importance of yeasts in determining overall wine quality.

Sequential and mixed fermentations have also been explored to enhance wine complexity. Cantarelli (1995) proposed the sequential use of *Torulaspora delbrueckii* (formerly *Saccharomyces rosei*) and *S. cerevisiae* to reduce acetic acid levels. Since then, non-*Saccharomyces* yeasts such as *Hanseniaspora*, *Metschnikowia*, *Pichia*, *Kluyveromyces*, and *Starmerella* species have been widely investigated for their contribution to aroma complexity and mouthfeel.

Wine style is determined by the relative concentrations of many volatile and non-volatile compounds derived from grapes, fermentation processes, and microbial activity (Polaskova et al., 2008; Styger et al., 2011). In a competitive wine market, adapting wine profiles to involving consumer preferences is essential (Cordente et al., 2012). Yeast selection represents a cost-effective tool for modulating wine characteristics from the same grape variety or vineyard.

While most studies have focused on volatile aroma compounds, particularly in white wines (Clemente-Jimenez et al., 2005; Varela et al., 2009) and red wines (Romano et al., 2003, 2008), fewer have addressed the impact of yeast on phenolic composition. In red wines, phenolic compounds significantly influence color, astringency, and mouthfeel (Mercurio et al., 2010). Yeast can affect both the extraction and transformation of phenolic compounds (Monagas et al., 2007; Morata et al., 2006), as well as their interaction with grape cell walls (Bindon et al., 2010 a,b) and their evolution during aging (McRae et al., 2012).

Therefore, the selection of yeast strains in red winemaking requires a careful balance between their effects on volatile and non-volatile components. This study aims to evaluate the influence of different yeast strains on the chemical composition and sensory profile of Cabernet Sauvignon wines, with particular emphasis on phenolic content, color, and sensory attributes.

MATERIALS AND METHODS

Fruit Source

Cabernet Sauvignon grapes were harvested in 2021 from a single vineyard block in Vojnica (Veles, North Macedonia) at 550 m a.s.l., at 24 °Brix.

Fruit Processing

Berries were hand-picked and processed at Kamnik Winery (Skopje, North Macedonia). Bunches were destemmed and divided into three 1-ton stainless-steel vats. During destemming, 1 ml/l of 5 % H_2SO_3 (≈50 ppm), 2 g/hl pectolytic enzyme, and 30 g/hl inactivated yeast were added to limit oxidation. Samples were taken for juice analyses: pH, titratable acidity (TA), yeast-assimilable nitrogen (YAN), and malic acid.

Winemaking Protocol

The must was placed in 1-ton stainless-steel vats, filled to 80% capacity, sealed, and kept at 20 °C overnight before inoculation. No tartaric acid or nitrogen was added. Yeast was inoculated at 30 g/hl. Fermentation temperature rose from 20 °C to 28 °C. Cap management involved three punch-downs daily to ensure the extraction of polyphenols. Fermentation progress was monitored by sugar loss (Oechsle scale). All lots were pressed the same day fermentation finished, using a wooden screw press. Wines were racked into 750 ml bottles without filtration. After 7 days, they were racked again and sulfated with 1 ml/l of 5% H_2SO_3 (≈50 ppm). Analyses were performed within one year.

Yeast Strains

Three commercial yeast strains were tested:

- **D-254** (*Lalvin ICV D-254*): selected from Syrah in the Rhône Valley; promotes high fore-mouth volume, rich mid-palate, smooth tannins, and mildly spicy finish; compatible with malolactic fermentation.
- **VRB** (*Uvaferm VRB*): selected in Rioja; enhances varietal character and ester expression; noted for good color intensity, stable phenolic structure, ripe-fruit and dried-plum notes, high alcohol tolerance (up to 17%), and low volatile-acidity production.
- **Clos** (*Lalvin Clos*): selected in Priorat (Tarragona); robust implantation under low-nitrogen conditions, enhancing aromatic complexity, structure, and mouthfeel.

Juice and Wine Analyses

Standardized procedures were followed for sugar content (Oechsle scale), YAN (Formol titration), pH (calibrated meter), TA (titration with 0.1 N NaOH), and residual sugar (Fehling's method with iodometric titration).

Tannin and Color Measurements

Spectrophotometric assays were used:

- **Total polyphenols:** Folin–Ciocalteu method, absorbance at 765 nm.
- **Total anthocyanins:** ethanol–water–HCl extraction, absorbance at 550 nm.
- **Color intensity:** measured at 420, 520, and 620 nm.

Sensory Evaluation

A trained panel evaluated color, aroma, flavor intensity, and persistence in a standardized tasting room using ISO wine glasses. A preference test was included.

RESULTS AND DISCUSSION

The initial composition of the Cabernet Sauvignon must (Table 1) indicated favorable conditions for fermentation, with a sugar content corresponding to a potential alcohol of 16.6% v/v, balanced acidity (pH 3.27; TA 5.25 g/L), and a relatively high yeast-assimilable nitrogen (YAN) concentration (384 mg/L). These parameters ensured optimal yeast performance without the need for nitrogen or acid corrections.

Table 1. Initial basic parameters of the juice sample

Juice sample	Initial sugar Oe/ t° / g/L	Potential alc Vol%	pH	TA (g/l)	YAN (g/l)	Malic acid (g/L)
Cabernet Sauvignon	117/15/282	16.6	3.27	5,25	384	1.23

The chemical composition of the resulting wines (Table 2) showed significant variation depending on the yeast strain used, despite identical vinification conditions. The "Clos" strain produced the highest alcohol content (15.99% v/v), indicating a strong fermentation capacity and efficient sugar conversion. In contrast, the "D-254" strain resulted in a notably lower alcohol level

(13.89% v/v), suggesting differences in fermentation kinetics or sugar utilization efficiency among strains.

Total acidity (TA) also varied among treatments, with the "D-254" wine showing the highest value (8.4 g/L), followed by "Clos" (7.4 g/L), while "VRB" exhibited the lowest acidity (6.2 g/L) and the highest pH (3.58). This may indicate a greater consumption of organic acids or differences in acid metabolism associated with the "VRB" strain. From an enological perspective, higher acidity contributes to freshness and microbial stability, whereas higher pH values may increase the risk of oxidation and reduce color stability.

Volatile acidity (VA) remained within acceptable limits across all samples (0.5–0.6 g/L), indicating that none of the yeast strains adversely affected fermentation hygiene. Residual sugar levels were low (3.8–4.2 g/L), indicating that all fermentations were essentially complete.
Significant differences were observed in extract content, with the "Clos" wine showing the highest value (37.2 g/L), followed by "VRB" (35.9 g/L) and "D-254" (33.6 g/L). Higher extract levels are generally associated with improved body and mouthfeel, which aligns with the sensory results.

Table 2. Basic parameters of the wine samples

Wine sample	Alc Vol%	pH	TA (g/L)	RS (g/L)	VA (g/L)	SO_2 (free/total)	Extract
Clos	15.99	3.22	7.4	3.8	0.5	16.6/40.96	37.2
D254	13.89	3.14	8.4	4.2	0.6	14.1/30.7	33.6
VRB	14.62	3.58	6.2	3.8	0.5	19.2/29.4	35.9

The most pronounced differences among the wines were found in phenolic composition (Table 3). The "VRB" strain resulted in a markedly higher total polyphenol content (5040 mg/L), more than double that of "Clos" (1601 mg/L) and significantly higher than "D-254" (2385 mg/L). This suggests that "VRB" enhances phenolic extraction or reduces phenolic loss during fermentation, potentially through weaker adsorption of phenolic compounds on yeast cell walls.

Similarly, total anthocyanin content was highest in the "VRB" wine (619 mg/L), compared to "Clos" (525 mg/L) and "D-254" (529 mg/L). Although the differences in anthocyanins were less pronounced than those observed for total polyphenols, they still indicate a positive effect of the "VRB" strain on color-related compounds. Color intensity values (A520) were similar among treatments, suggesting that co-pigmentation phenomena or polymeric pigment formation may also play a role beyond simple anthocyanin concentration.

The elevated phenolic content observed in the "VRB" wine is particularly important for red wine quality, as phenolic compounds contribute to color stability, antioxidant capacity, and aging potential. These findings are consistent with previous studies indicating that yeast strains can influence phenolic extraction and transformation during fermentation.

Table 3. Wine analysis of total polyphenol composition

Wine sample:	Clos	D254	VRB
Total polyphenols (765 nm) mg/L	1601	2385	5040
Total anthocyanin (540 nm) mg/L	525	529	619

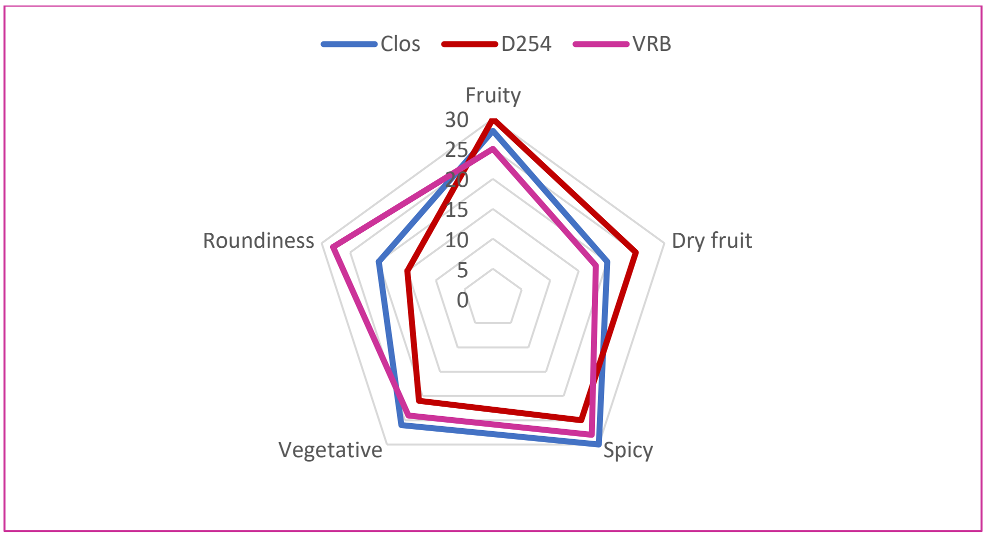
Color	-	520	3065	3064	3064

Sensory evaluation (Graphic 1) further supported the analytical results. Wines produced with the "Clos" strain were characterized by enhanced varietal typicity, particularly fruity and spicy notes, and a well-balanced structure. This may be attributed to its ability to preserve acidity and promote the formation of specific aroma compounds.

The "D-254" wine exhibited a medium body with pronounced fruity aromas, making it suitable for early consumption. Its higher acidity and moderate extract contributed to a fresher but less structured profile compared to the other samples.

In contrast, the "VRB" wine was perceived as fuller-bodied, with a more pronounced tannin structure and greater overall complexity. These sensory attributes are consistent with its higher polyphenol content and suggest a greater suitability for aging.

Overall, the results clearly demonstrate that yeast strain selection significantly influences both the chemical composition and sensory profile of Cabernet Sauvignon wines. The observed differences highlight the importance of matching yeast characteristics with the desired wine style and production goals.



Graphic 1. Sensory analysis descriptors

CONCLUSION

This study demonstrated that yeast choice significantly influences Cabernet Sauvignon wine composition, particularly color, phenolic structure, and sensory profile.

Among the strains tested:

- **VRB** delivered the deepest color and highest polyphenol concentration, supporting aging potential and a rounded mouthfeel.
- **Clos** combined robustness with the highest alcohol level and stable acidity, key for freshness, balance, and varietal spicy notes.
- **D-254** contributed medium body and pronounced fruity aromas, making it suitable for wines aimed at early consumption and faster market turnover.

Each strain offers unique advantages depending on the desired wine style, market segment, and price positioning. Future research should explore interactions between yeast strains and other grape varieties or fermentation conditions to optimize wine quality further.

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