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Evaluation of yeast derivatives on Sauvignon blanc wine quality

Original Article

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Abstract:

The combined effect of the native yeast strain *Hanseniaspora uvarum* S-2 with commercial yeast derivatives (YDs) on the quality of Sauvignon blanc wine was evaluated. Three commercial YDs were applied at two concentrations (0.2 g/L or 0.4 g/L) over a 15-day period with periodic stirring. Dissolved oxygen content, browning index, total phenolic content, and sensory profile were examined. Results indicated that YDs effectively scavenged oxygen, with lower dissolved oxygen in treated samples than the control. The lowest oxygen content was observed in the wine treated with 0.2 g/L of commercial YD Noblesse (Lallemand, Canada). Total phenolic content did not significantly differ between YDs, but treated wines exhibited more stable color. Browning index was improved in samples with higher derivative doses. Overall, all YDs resulted in wines with comparable sensory profiles, although statistically different scores for taste attributes. The findings confirm that YD treatment mitigates oxidative browning during white wine storage and positively influences sensory aspects.

Key words:
yeast derivatives, Sauvignon blanc, wine

Apstrakt:

Uticaj derivata kvasca na kvalitet vina sorte Sauvignon blanc

Istraživanje je imalo za cilj da ispita kombinovani uticaj nativnog soja kvasca (*Hanseniaspora uvarum* S-2) i tri različita komercijalna derivata kvasca na kvalitet vina Sauvignon blanc. Komercijalni derivati su primenjeni u dve koncentracije (0.2 g/L ili 0.4 g/L) tokom 15-dnevnog perioda uz povremeno mešanje. Uzorcima vina određen je sadržaj rastvorenog kiseonika, stepen potamnjivanja, ukupni sadržaj fenola i senzorne karakteristike. Rezultati su ukazali da upotreba derivata kvasaca efikasno redukuje prisustvo kiseonika, što se ogleda u nižem sadržaju rastvorenog kiseonika u tretiranim vinima u poređenju sa kontrolom. Najniži sadržaj kiseonika zabeležen je kod vina tretiranog komercijalnim derivatom Noblesse (Lallemand, Kanada) u koncentraciji 0.2 g/L. Sadržaj ukupnih fenola nije se značajno razlikovao između vina tretiranih različitim derivatima, ali su tretirana vina imala stabilniju boju. Bolji rezultati za stepen potamnjivanja dobijeni su kod primene većih doza derivata. Generalno, sva vina tretirana derivatima su rezultirala vinima sličnih senzornih profila, iako su statistički različite ocene zabeležene za ukus dobijenih vina. Dobijeni rezultati potvrđuju da tretman derivatima kvasaca smanjuje oksidativno potamnjivanje tokom skladištenja belog vina i pozitivno utiče na senzorne karakteristike.

Ključne reči:
derivati kvasca, Sauvignon blanc, vino

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Introduction

Wine is a complex system that undergoes numerous chemical changes during storage. While bottle storage can lead to quality improvement in some red wines (Echave et al., 2021), in white wines, it mainly causes color alteration (browning), loss of fresh and fruity aromas, the appearance of the oxidized character, and unpleasant odors (Kanavouras et al., 2020; Vlahou et al., 2022). The main chemical reactions responsible for wine changes during bottle storage are non-enzymatic oxidation reactions responsible for an adverse change in color due to an increase in color intensity and a decrease in brightness (Ricci et al., 2017). Enzymatic reactions usually induce browning during the early stages of wine production (Tarko et al., 2020), while non-enzymatic oxidation usually occurs in the post-fermentation phase, when the active polyphenol oxidase is not present in wine, leading to the appearance of brown color and ‘‘woody” aroma. It is confirmed that the oxidative browning of white wines is mainly related to the content of flavanols

and hydroxycinnamates. These compounds mainly participate in redox reactions that occur during wine aging (Salacha et al., 2008). Mostly, the formation of yellow or brown products due to the polymerization of ortho-quinones is the result of the oxidation process of (+)-catechin, (-)-epicatechin, caffeic, and other hydroxycinnamic acids (Mitić et al., 2010). Besides polyphenol oxidation, transition metal ions, sulphur dioxide concentration, and ascorbic acid also contribute to the oxidation of polyphenols since sulphur dioxide and ascorbic acid can reduce the concentration of ortho-quinones, and metal ions catalyze the oxidation process (Salacha et al., 2008; Mitić et al., 2010). Conversely to red wines, white wines are susceptible to oxidation due to low total phenolic content (Tarko et al., 2020).

Traditionally, compounds such as sulphur dioxide, ascorbic acid, tannins, or fresh lees are added to wine to prevent oxidation. More recently, inactive yeast derivatives (YDs) have been proposed as an efficient tool for preventing wine oxidation due to the ability to release glutathione and other antioxidant compounds (Comuzzo et al., 2015; Nioi et al., 2022). YDs, such as inactivated yeast, yeast autolysate, yeast protein extract, yeast cell wall, and yeast mannoprotein, refer to a fraction of yeast cells obtained in the different production processes and degrees of purification (Del Barrio Galán et al., 2018). YDs could improve the mouthfeel, aromatic profiles, and stability of the wine, reduce the perception of acidity and bitterness and prevent or reduce the oxidation of the wine. The listed effects strongly depend on YD type, characteristics, and dosage, while their protective action was mainly due to the compounds like peptides, amino acids, glutathione, and polysaccharides (Nioi et al., 2022). The use of commercial YDs containing these compounds has significantly increased in recent years. Since color is one of the very important sensory characteristics of white wine, there are specifically formulated YD, which aims to suppress the oxidation phenomena and improve the color of wines (Pozo-Bayon et al., 2009; Del Barrio Galán et al., 2018). YDs are usually produced from *Saccharomyces cerevisiae* cultivated on sugar-rich medium. Afterwards, the cells are subjected to autolysis by different methods and dried to obtain the powder preparations. The application of different YDs depends on their composition and covers a broad range of activities during wine production (Del Barrio Galán et al., 2018). Some YDs can be used to improve alcoholic or malolactic fermentation (Del Barrio-Galán et al., 2019), and others can act as protective agents, flavor enhancers, or aroma precursors (Pons-Mercadé et al., 2021).

Nevertheless, many types of YDs present on the market for various applications in winemaking, but the mechanisms of YDs actions which result in the wine's improvements are not completely clear. Accordingly, additional scientific research is needed to characterize the YDs effects and establish better criteria for their oenological use. Furthermore, to our knowledge, no study has investigated the combined effect of YDs and native non-*Saccharomyces* yeast strains on wine quality. However, recently, there has been a growing interest in using non-*Saccharomyces* yeasts in many innovative wineries. Therefore, the objective of the present study was to evaluate the effect of the previously characterized native yeast strain (*Hanseniaspora uvarum* S-2) (Mančić et al., 2022; Karabegović et al., 2022; Stamenković Stojanović et al., 2023), in combination with three different commercial products based on yeast autolysates, on the white wine quality and aging process during the storage in bottles. This work constitutes a direct approach to understanding the action mode of these preparations and establishing better criteria for their use during winemaking.

Materials and Methods

Wine production and treatment

The grapes were harvested at technical maturity, destemmed, crushed, and pressed. After sedimentation, grape juice (21.3 Brix, 5.67 g/L total acidities, and pH 3.2) was inoculated with an native yeast strain, previously isolated and identified as *Hanseniaspora uvarum* S-2 (Mančić et al., 2022; Karabegović et al., 2022; Stamenković Stojanović et al., 2023). The inoculum was prepared by transferring a full loop of the strain *H. uvarum* S-2 from the plate into Sabouraud dextrose broth containing 80 mg/L chloramphenicol, followed by incubation at 25 °C for 48 hours on a rotary shaker at 120 rpm. After 48 hours, the resulting biomass was centrifugated and added to the must in an amount previously calculated to achieve a final concentration of 10^6 CFU/mL. The fermentation was performed under a controlled temperature (16–21 °C) until dryness (reducing sugar content below 4 g/L). After fermentation, the obtained wine was divided into nine glass vessels (50 L). Three commercial YDs based on inactive yeast, available on the market as Optimum White, Opty Less, and Nobless (Lallemand, Canada), were applied in two concentrations (0.2 g/L or 0.4 g/L) for 15 days, with stirring every third day. While all three yeast derivatives are based on inactivated *S. cerevisiae* and aim to improve wine quality, they each offer unique benefits: Noblesse focuses on enhancing sensory complexity and supporting fermentation processes, Optimum White emphasizes antioxidant protection and prolonging the freshness and fruitiness of white and rosé wines, while

Optilees targets the improvement of wine texture and accelerates the maturation process for a fuller taste profile. After treatment, wine clarification was done (using bentonite, gelatin, and SiO_2), followed by filtration and bottling. Untreated wines were used as control. After bottling, one part of the bottles was subjected to accelerated aging by heating filtered wine samples (20 mL) in screw-cap glass vials (30 mL) at 55.0±0.2 °C for 10 days (Singleton & Kramling, 1976), while the other part was stored in a dark place at 15–20 °C for one year under normal conditions. The browning index, dissolved oxygen content and total phenolic content of wine samples were monitored in four different production stages: before clarification and filtration (W), after clarification and filtration (CFB), after accelerated aging (ACC) and after one year of aging in normal conditions (NOR).

Dissolved oxygen content

Dissolved oxygen content was measured by a polarographic oxygen analyzer (YSI model 51A dissolved oxygen meter, Yellow Springs Instruments CO).

Determination of total phenolic content

Total phenolic content was determined using the Folin-Ciocalteu assay (Ivanova et al., 2010). Gallic acid was a standard, and the results were reported as mg gallic acid equivalents (GAE)/L.

Browning index

The browning (absorbance at 420 nm) was measured against 12% ethanol. The percentages of changes in browning (%Δ) was calculated as follows:

$$\%\Delta=(A_n-A_0)*100/A_n$$

where A_0 and A_n were the browning index (absorbance at 420 nm) at the begging of the treatment and after certain production stages (W, CFB, ACC, NOR), respectively.

Sensory evaluation

The panel method was used for sensory evaluation. A panel of five judges (members of the Commission of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia for the organoleptic assessment of wine and similar products) evaluated various smell (overall odor, spice, honey, tobacco, vegetable, citrus, tropical fruit, dry fruit, fresh fruit, flowers, complexity, duration, intensity, and typicality) and taste (overall taste, typicality, intensity, duration, complexity, fulness, astringency, acidity, harmony) attributes using a ten-point intensity scale, ranging from 0 (not detected) to 10 (very intense). The evaluations were performed in triplicate after one year of aging in normal conditions (NOR), and the results were presented as the mean value.

Statistical analysis

All experiments were conducted in triplicate and the results are expressed as the average value with standard deviation. Significant differences between samples were assessed using One-Way ANOVA followed by Tukey's HSD post hoc test (IBM SPSS Statistics software, New York, USA). Differences were considered statistically significant at a p-value of less than 0.05.

Results and discussion

Oxygen content through all the phases of winemaking and aging can affect the quality of the final product. Some literature data indicate that 20–50 mg O_2/L is the amount of oxygen the white wine could absorb before negative oxidative defects appear (Tarko et al., 2020). It implies that oxygen control during winemaking and bottling is very important in high-quality wine production. Oxygen content measured in all wine samples during wine production in different production stages is presented in **Fig. 1** (**Appendix 1**).

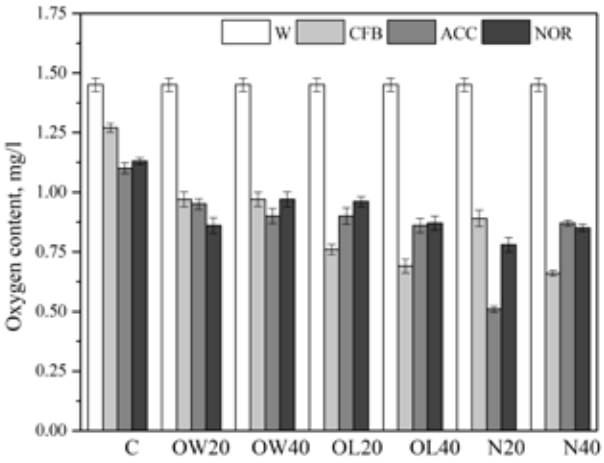

Fig. 1. Oxygen content in wine samples treated by YDs (C – control, OW20 – Optimum White 0.2 g/L, OW40 – Optimum White 0.4 g/L, OL20 – Opty Less 0.2 g/L, OL40 – Opty Less 0.4 g/L, N20 – Nobless 0.2 g/L, N40 - Nobless 0.4 g/L) in different production stages (W – Before treatment, CFB – after clarification and filtration, ACC – after accelerated aging and NOR - after one year of normal aging conditions)

The results indicate that all used commercial YDs have good oxygen scavenging properties since treated samples had lower oxygen content than the untreated wine (control sample). The most active

oxygen scavengers among the tested products were Nobless, followed by Opty Less, while the dosage of YDs had a negligible effect. After the accelerated aging test, it was also found that dissolved O_2 concentrations were lower in all treated wines than in the control sample, which was particularly pronounced in the sample treated with Noblesse, with a concentration of 0.2 g/L (0.79 mg/L, compared to 1.45 mg/L for the control sample). After one year in the bottle, there were similar results to those obtained after accelerated aging, with dissolved O_2 concentrations in all treated wines also lower than in the control sample. Although good oxygen consumption capacity was recently found for some YDs (commercial Pure-Lees™ Longevity and experimental Antiox-1), the same authors claim that Noblesse has no oxygen consumption capacity (Pons-Mercadé et al., 2021). This difference can probably be attributed to the vinification conditions, the chemical profile of the wine, the free SO_2 content, or the oxidative evolution during storage. However, it is important to note that Noblesse, according to the manufacturer's specification, is characterized as a derivative that, besides other benefits, can prevent oxidation.

The total phenolic content (TPC) in the wine samples ranged from 402 to 362 mg GAE/L (**Tab. 1**). Although the obtained results are significantly higher than the TPC found in Sauvignon blanc wine (165 to 242 mg GAE /L) from different wine regions of the world (New Zealand, Chile, South Africa) (Marais, 1998; Olejar et al., 2015; Díaz et al., 2021), the results are consistent with the TPC in Slovenian Sauvignon blanc wine (Lužar et al., 2016) and with the previously reported average TPC for ten different Serbian white wines (Mitić et al., 2010). The diversity of results is probably related to the geographical region, climate, vintage, vinification, and aging conditions or the analysis methods used.

Regardless of YDs treatment, a significant decrease (about 5%) in total phenolic content was observed in all samples after clarification and filtration. This decrease is because clarifying agents such as bentonite, apart from protein, also adsorb or interact with phenolic compounds, thus also decreasing their content (He et al., 2020). However, it can be noted that after the accelerated aging or one year of aging under normal conditions, TPC in all treated wines was significantly higher than in the control sample. Such results indicate that YDs treatment can mitigate polyphenols' transformation and/or precipitation during wine aging.

A good indicator of the susceptibility of wine to oxidation is the development of a brown color, which increases the color intensity and the browning index. The obtained results (**Fig. 2**, **Appendix 2**) show that the clarification of the wine with a

Table 1. Total phenolic content (mg GAE/L) in wine samples treated by YDs in different production stages

Production stages	Wine treatment						
	C	**OW20**	**OW40**	**OL20**	**OL40**	**N20**	**N40**
W	402.02±4.51	402.02±4.51	402.02±4.51	402.02±4.51	402.02±4.51	402.02±4.51	402.02±4.51
CFB	383.68±3.12a	381.35±5.22a	384.72±1.96a	382.34±4.90a	383.48±1.77a	384.56±3.86a	382.45±4.88a
ACC	365.56±5.29a	384.49±3.18b	383.33±6.71b	386.47±0.92b	381.65±4.79b	382.15±4.29b	384.63±4.33b
NOR	362.84±6.02a	383.36±1.05b	384.18±2.83b	383.45±5.33bc	385.33±4.82bc	386.67±1.79c	387.33±1.49c

* C – control, OW20 - Optimum White 0.2 g/L, OW40 - Optimum White 0.4 g/L, OL20 - Opty Less 0.2 g/L, OL40 - Opty Less 0.4 g/L, N20 - Nobless 0.2 g/L, N40 - Nobless 0.4 g/L, W- Before treatment, CFB – after clarification and filtration, ACC – after accelerated aging and NOR – after one year of normal aging conditions. Different letters indicate statistically significant differences in the same row ($p<0.05$)

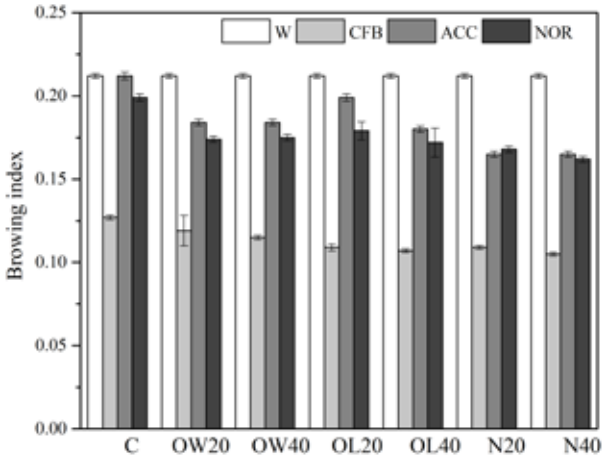

Fig. 2. Browning index in wine samples treated by YDs (C – control, OW20 – Optimum White 0.2 g/L, OW40 – Optimum White 0.4 g/L, OL20 – Opty Less 0.2 g/L, OL40 – Opty Less 0.4 g/L, N20 - Nobless 0.2 g/L, N40 – Nobless 0.4 g/L) in different production stages (W- Before treatment, CFB – after clarification and filtration, ACC – after accelerated aging and NOR – after one year of normal aging conditions)

combination of the mentioned agents (bentonite, gelatine, and SiO_2) had a significant effect on the reduction of the browning index, while the results also clearly confirm the positive influence of YDs after this production stage. Furthermore, it is evident that the treated wines also have both a significantly lower browning index than the control sample after accelerated aging and after one year under normal conditions. The obtained results agree with those of other authors (Razmkhab et al., 2002; Pozo-Bayon et al., 2009).

Although Nobless treatment had a slightly better effect on the browning index than other YDs, the applied dose had no significant effect for all treated samples.

The sensory evaluation indicates that YD treatments had a slight overall positive effect on the sensory characteristics (**Fig. 3**). After bottling and one year of storage under standard conditions, the treated wines showed more intense smell attributes such as harmony and complexity and a more pronounced tropical fruit and honey character, compared to the control sample. As for the taste atributes, a significant improvement was observed in fullness, structure, complexity, harmony, and duration, accompanied by a decrease in astringency.

Conclusion

In conclusion, our results indicate that YDs treatment could be a suitable technique for the white wine industry to prevent or reduce oxidative processes that could negatively affect final quality. Nevertheless, oenologists have to consider that the YDs dose did not play a significant role, so it can be concluded that a concentration of 0.2 g/L is sufficient to achieve a satisfactory effect.

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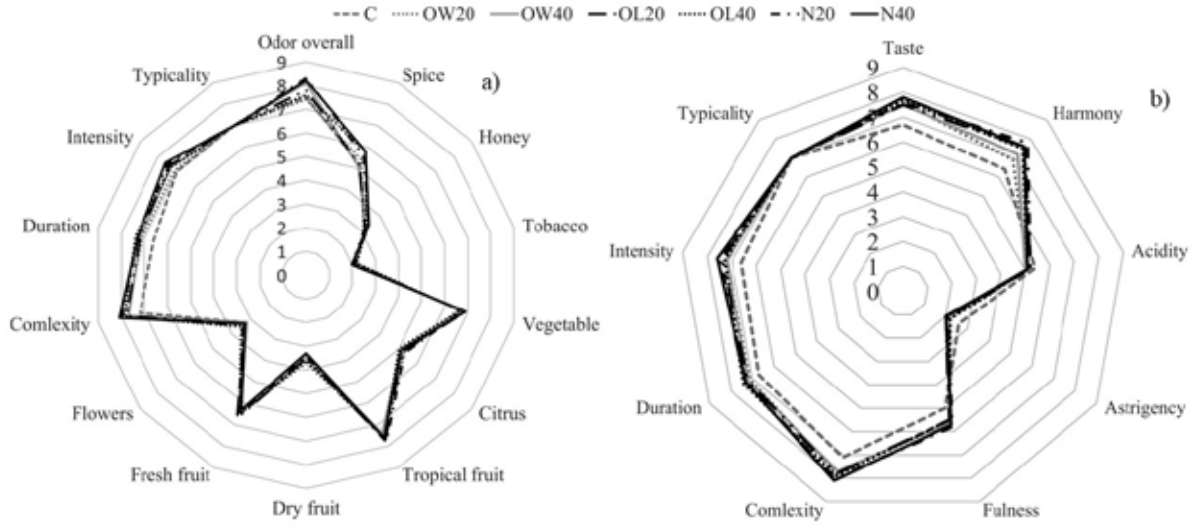

Fig. 3. Results of the sensory analysis for smel (a) and taste (b) attributes of wine samples treated by YDs (C – control, OW20 – Optimum White 0.2 g/L, OW40 – Optimum White 0.4 g/L, OL20 – Opty Less 0.2 g/L, OL40 – Opty Less 0.4 g/L, N20 – Nobless 0.2 g/L, N40 – Nobless 0.4 g/L) after one year of normal aging conditions

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Appendices

Appendix 1. Oxygen content (mg/L) in wine samples treated by YDs in different production stages

Production stages	Wine treatment						
	C	OW20	OW40	OL20	OL40	N20	N40
W	1.451±0.028	1.451±0.028	1.451±0.028	1.451±0.028	1.451±0.028	1.451±0.028	1.451±0.028
CFB	1.271±0.019a	0.972±0.031b	0.971±0.026b	0.760±0.021c	0.690±0.029d	0.791±0.034c	0.660±0.012d
ACC	1.101±0.022a	0.951±0.023b	0.901±0.032bc	0.901±0.035bc	0.861±0.030cd	0.510±0.012e	0.871±0.013d
NOR	1.131±0.014a	0.861±0.033b	0.970±0.036c	0.961±0.021c	0.871±0.030b	0.780±0.030d	0.851±0.015b

*C – control, OW20 - Optimum White 0.2 g/L, OW40 - Optimum White 0.4 g/L, OL20 - Opty Less 0.2 g/L, OL40 - Opty Less 0.4 g/L, N20 - Nobless 0.2 g/L, N40 - Nobless 0.4 g/L, W- Before treatment, CFB – after clarification and filtration, ACC – after accelerated aging and NOR – after one year of normal aging conditions. Different letters indicate statistically significant differences in the same row ($p < 0.05$)

Appendix 2. Browning index in wine samples treated by YDs in different production stage

Production stages	Wine treatment						
	C	OW20	OW40	OL20	OL40	N20	N40
W	0.212±0.001	0.212±0.001	0.212±0.001	0.212±0.001	0.212±0.001	0.212±0.001	0.212±0.001
CFB	0.127±0.004a	0.119±0.009b	0.115±0.001b	0.109±0.002bc	0.107±0.002c	0.109±0.001b	0.105±0.002c
ACC	0.212±0.002a	0.184±0.002b	0.184±0.002b	0.199±0.002c	0.180±0.002b	0.165±0.001d	0.165±0.002d
NOR	0.199±0.002a	0.174±0.002b	0.175±0.002b	0.179±0.005b	0.172±0.008b	0.168±0.001c	0.162±0.002d

*C – control, OW20 - Optimum White 0.2 g/L, OW40 - Optimum White 0.4 g/L, OL20 - Opty Less 0.2 g/L, OL40 - Opty Less 0.4 g/L, N20 - Nobless 0.2 g/L, N40 - Nobless 0.4 g/L, W- Before treatment, CFB – after clarification and filtration, ACC – after accelerated aging and NOR – after one year of normal aging conditions. Different letters indicate statistically significant differences in the same row ($p < 0.05$)