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Circular microbial biotechnology for improving colour and aroma in rosé wines produced in warm climates

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Abstract

Global rosé wine production is on the increase, but high temperatures in warm climates influence colour intensity and aromatic freshness, ultimately affecting sensory quality [1,2]. Applying non-*Saccharomyces* yeasts and lactic acid bacteria in combination with *Saccharomyces cerevisiae* in sequential inoculations offers a promising strategy to enhance colour expression and aromatic complexity during fermentation [3]. In this study, six pilot-scale fermentations (500 L each) were carried out using Nero d'Avola grape must, with co-inoculations of either *Starmerella lactis-condensi* MN412 or *Candida oleophila* YS209, with or without *Lactiplantibacillus plantarum* MLPKH45™, followed by sequential inoculation with *S. cerevisiae* NF213. Fermentation kinetics, microbial dynamics, CIELab colour parameters, and sensory profiles were monitored. Sequential inoculation accelerated fermentation compared to the control with *S. cerevisiae*, showing positive microbial interactions. All mixed fermentation trials showed significantly higher L*values (up to 67.20*vs*57.67) and lower C* values (17 *vs* 24.52), suggesting lighter hues and lower colour saturation. Total colour differences (ΔE) between treatments and the control reached up to 12.2, well above the visual perception threshold (ΔE > 2.7) [4]. Sensory analysis showed that sequential inoculations enhanced floral (up to 6.7) and red fruit notes (up to 6.5). The combination of *C. oleophila* YS209 + *L. plantarum* MLPKH45™, followed by *S. cerevisiae*, provided the best balance between colour intensity and sensory quality, achieving the highest overall score (7.5 *vs* 6.5 for the control). Overall, the results demonstrate that co-inoculation of *non-Saccharomyces* yeasts and lactic acid bacteria, coupled with sequential inoculation of *S. cerevisiae*, is an effective tool for modulating colour and aroma in rosé wines produced in warm climates. This approach supports more sustainable winemaking practices with reduced reliance on chemical additives.

Reference

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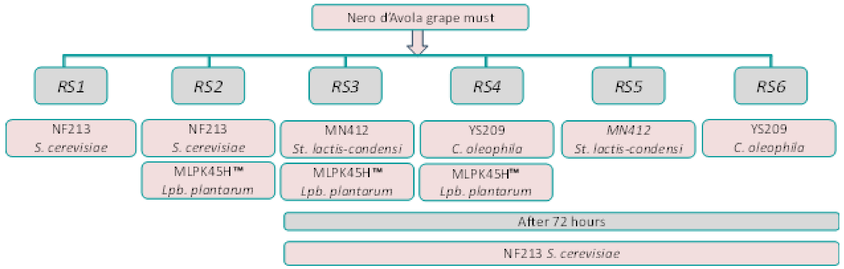
BACKGROUND

- Global rosé wine production has increased in recent years.
- Climate change reduces wine freshness, promotes cooked-fruit aromas, and affects wine colour.
- Microbial strategies may modulate wine characteristics during fermentation.

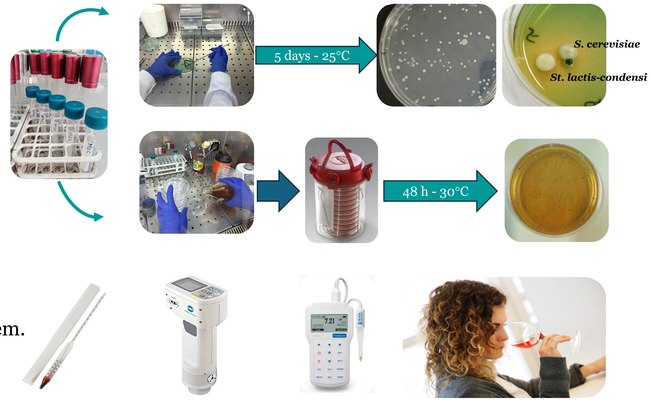
OBJECTIVE

To evaluate the effect of co-inoculation of non-*Saccharomyces* yeasts and lactic acid bacteria (LAB), followed by sequential inoculation of *Saccharomyces cerevisiae*, on the colour and aromatic profile of rosé wines.

METHODOLOGY



Starmerella lactis-condensi MN412 isolated from Sicilian manna; *Candida oleophila* YS209 isolated from honey by-products; *Saccharomyces cerevisiae* NF213 from grapes; *Lactiplantibacillus plantarum* MLPK45TH commercial strain



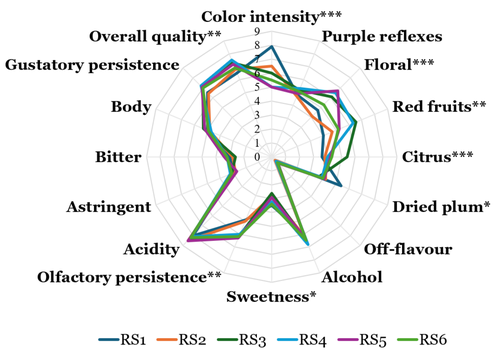
- Fermentation trials were carried out in 500-L tanks.
- Microbial populations were monitored on WL agar, MRS, GM17 media.
- Colour was evaluated using the CIELab colour system.
- Sensory analysis was performed by a trained panel.

RESULTS AND CONCLUSIONS

Samples	L*	a*	b*	C	h
RS1	57.67 ± 0.53 d	20.93 ± 0.51 a	12.77 ± 0.46 a	24.52 ± 0.67 a	31.38 ± 0.36 a
RS2	62.15 ± 0.96 c	19.55 ± 0.31 ab	9.93 ± 0.54 b	21.93 ±0.44 b	26.92 ± 1.15 ab
RS3	61.65 ± 0.32 c	19.15 ± 0.61 bc	10.25 ± 0.93 b	21.74 ± 0.13 b	28.17 ± 2.93 ab
RS4	66.46 ±0.61 a	16.05 ± 0.79 d	6.30 ± 0.18 d	17.24 ± 0.79 d	21.45 ±0.62 c
RS5	67.20 ± 0.17 a	14.97 ± 0.57 d	8.02 ± 0.84 c	17.00 ± 0.19 d	28.19 ± 3.36 ab
RS6	63.95 ± 0.48 b	17.96 ± 0.27 c	7.66 ± 0.21 cd	19.53 ± 0.27 c	23.10 ± 0.65 bc
p -value	≤ 0,0001	≤ 0,0001	≤ 0,0001	≤ 0,0001	≤ 0.001

ΔE

	0	3	5	7	9	12
RS1	0.00					
RS2	5.48	0.00				
RS3	5.04	0.72	0.00			
RS4	11.96	6.63	6.95	0.00		
RS5	12.20	7.08	7.30	2.16	0.00	
RS6	8.62	3.30	3.66	3.43	4.43	0.00



- Mixed fermentations modulated wine colour, resulting in paler rosé wines.
- Co-inoculation of non-*Saccharomyces* yeasts and LAB enhanced aromatic complexity.
- Microbial strategies may help control rosé wine characteristics in warm climates.
- This approach supports more sustainable winemaking by reducing the need for chemical corrections.

L*: lightness (0= black, 100= white); a*: redness (a* +) → greenness (a* -); b*: yellowness (b* +) → blueness (b* -); C: colour saturation and intensity; h: hue angle (colour nuance); ΔE: total colour difference (human perception threshold ΔE > 2.7). ↑L*: Lighter colour; ↓ C: lower saturation.

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