Influence of sequential and mixed fermentations with non-Saccharomyces yeasts on the sensory profile of red wine

Introduction

One of the main opportunities for using non-Saccharomyces yeasts is its great intraspecific variability in relation to the synthesis of secondary products of fermentation [1]. Mixed or sequential fermentations with non-Saccharomyces yeasts can potentiate colour stability by vitisins synthesis [2, 3, 4], or formation of vinylphenolic pyranoanthocyanins (VPAs) due to HDCP activity [5].

Regarding the aromatic profile, mixed and sequential fermentations allow increasing concentrations of some interesting compounds in red wine as ethyl lactate, 2,3-butanediol, 2-phenylethanol and 2-phenylethyl acetate [2, 4, 6]. Moreover, producing red higher alcohols like 1,2-propanediol, glucose, 2,4,6-trihydroxyphenylacetic acid (TPA) and pyranoanthocyanins [6], T. delbrueckii species is characterized by its high purity fermentation and thus has low production of glycerol, acetaldehyde, acetic acid and ethyl acetate [7]. When used in sequential or mixed fermentations with S. cerevisiae allows correcting certain defects in wines as volatile acidity [8].

S. pombe species is highly appreciated in cold regions because of its ability to completely transform the malic acid of the must into ethanol thanks to its maloalcoholic fermentation [9]. Moreover, their high ability to synthesize pyruvic acid (vitisin A precursor) and glycerol was recently described [3, 10]. The aim of this work is to evaluate the influence of S. pombe and T. delbrueckii species on the sensory quality of red wine when used in sequential and mixed fermentations with S. cerevisiae.

Materials and Methods

Three representative strains of each non-Saccharomyces species, Saccharomyces pombe and Torulaspora delbrueckii, were assessed in sequential and mixed fermentations with a Saccharomyces cerevisiae strain. S. cerevisiae ‘7VA’ (HDCP+) (InotecUPM, Madrid, Spain) was used as control strain in pure fermentation (PE) [5].

The fermentation assay was performed in triplicate at 23 ºC using a must of Syrah grapes (Vitis vinifera L.) with 220 g/l of initial sugar content and pH 3.5. In sequential fermentations (SF), 70 ml of must in 100 ml flasks were inoculated with 1 ml of 7VA strain and after 7 days the second inoculation was performed with 1 ml of 7VA strain. On the other hand, mixed fermentations (MF) were inoculated with 1 ml of non-Saccharomyces species, T. delbrueckii strains. Mean ± SD (n=3) ±

Table 1: Glycerol, tartaric acid and lactic acid content (g/l) of wines obtained from mixed and sequential fermentations with S. pombe and T. delbrueckii. Mean ± SD (n=3)

<table>
<thead>
<tr>
<th>Species</th>
<th>Alcohol</th>
<th>Mixed Fermentation</th>
<th>Sequential Fermentation</th>
<th>Pure Fermentation</th>
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<tbody>
<tr>
<td>S. pombe</td>
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<td>T. delbrueckii</td>
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<tr>
<td>S. cerevisiae</td>
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<tr>
<td>Glycerol</td>
<td>7.0 ± 0.0</td>
<td>7.0 ± 0.1</td>
<td>6.4 ± 0.1</td>
<td>6.0 ± 0.2</td>
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<tr>
<td>Lactic acid</td>
<td>2.9 ± 0.0</td>
<td>2.9 ± 0.1</td>
<td>3.3 ± 0.1</td>
<td>3.2 ± 0.1</td>
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<tr>
<td>Acetic acid</td>
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</tbody>
</table>

Results and Discussion

All fermentations ended with an alcoholic strength ranging from 13-13.4 % v/v. In general, the highest glycerol contents were produced in MF reaching ~7 g/l. (Table 1). SF kept slightly more tartaric acid in free form than MF, reaching mean values of up to 3.3 g/l (Table 1). MF in general, and particularly with S. pombe, was the one with highest concentrations of lactic acid produced during the fermentation (~0.20 g/l). Table 1. One of the major disadvantages of the use of S. pombe species is its greater acetic acid synthesis (0.5-0.7 g/l), what can be controlled in MF or SF with S. cerevisiae.

MF had higher values of monomeric, acetylated and coumarylated anthocyanins than SF, especially with T. delbrueckii strains, what is reflected in the higher total anthocyanin content (Figure 1). S. pombe strains in SF highlighted positively by its greater vitisins synthesis (Figure 2a), especially a type (3). However, in MF both species produced similar amounts, probably due to the greater influence of the S. cerevisiae strain. As for VPAs, its synthesis was higher in MF. Maximum concentration was reached with T. delbrueckii species (~1.5 mg/l) (Figure 2b).

MF with T. delbrueckii species allowed increasing fruity aromas in the wine by synthesizing larger amounts of esters (Table 2). In turn, MF in general, produced significantly higher concentrations of polyols. On the other hand, SF enhanced herbaceous aromas (1-hexanol), but decreased the presence of total higher alcohols, primarily with S. pombe species. T. delbrueckii species in SF can produce significant amounts of 3-ethoxy-1-propanol (blackcurrant flavour). As a general rule, for all the analysis performed, the biggest differences between species were registered in sequential fermentations. It certifies that this type of fermentation is suitable for enhancing the expression of the non-Saccharomyces yeasts’ metabolic particularities, whereas with mixed fermentations with S. pombe species, total higher alcohols formation is achieved.

Conclusions

The use of Schizosaccharomyces pombe and Torulaspora delbrueckii species in sequential and mixed fermentations with Saccharomyces cerevisiae may improve the sensory profile of red wine by enhancing aromatic complexity and increasing colour stability.

References


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Figure 1. Total anthocyanin content (mg/l) in mixed and sequential fermentations with S. pombe and T. delbrueckii strains. Mean ± SD (n=3). Bars with the same letter are not significantly different (p<0.05).

Figure 2. Vitisins and vinylphenolic pyranoanthocyanins content (mg/l) in mixed and sequential fermentations with S. pombe and T. delbrueckii strains. Mean ± SD (n=3). Bars with the same letter are not significantly different (p<0.05).

Figure 3. Yeast species used in the fermentative assay: A. S. cerevisiae; B: T. delbrueckii; C. S. pombe.