Lowering wine alcohol content by reverse osmosis and spinning cone columns: effects on sensory characteristics of the beverages

>>> Reverse osmosis and spinning cone columns are promising techniques for reducing alcohol content in wines. Most wineries are only interested in reducing ethanol content by one or two alcoholic degrees in order to obtain more balanced wines. However, new consumption habits and alcohol safety laws have induced the wine industry to produce new beverages from non-alcoholic or low alcohol wines. The aim of this study was therefore to evaluate the impacts of the dealcoholisation of wines by reverse osmosis and spinning cone columns on the sensory characteristics of the final product. <<<

Currently, warm climate viticultural regions provide grapes with a high potential alcohol value[1]. This results in unbalanced wines since aromatic and phenolic maturity does not coincide with pulp maturity, making it more difficult to define a correct harvest date[1]. Different alternatives to mitigate the negative effects of climate change on grape and wine quality have been proposed from a viticultural and oenological point of view[1, 2]. Nowadays, the most commonly used methods for reducing alcohol content in wines are the physical ones, such as the spinning cone column and reverse osmosis[1].

Beverages obtained from the partial dealcoholisation of wines have an alcoholic strength per volume equal to or above 0.5 % (v/v) and less than the applicable minimum alcoholic strength of wine or special wine[3]. Beverages obtained from the total dealcoholisation of wine are those produced from wine which has been dealcoholised to an alcoholic strength of below 0.5 % (v/v)[3]. Currently, the methods and practices for the production of these beverages are being studied for the International Organization of Vine and Wine (OIV). Sensory characterisation is an essential part of such research in order to evaluate the sensory attributes and hedonism of the beverages obtained from the dealcoholisation of wines.

■ Materials and methods

Our research was carried out in the "Cooperativa Agrícola Vitivinícola Loncomilla" winery located in San Javier, Chile on Cabernet Sauvignon and Listán Prieto (cv. País) wines produced from the 2013 vintage. The wines were dealcoholised by reverse osmosis (RO) to an ethanol content of 0.5 and 6.0 % (v/v) using an Oliversep 4 RO kit with 8 double membranes. Spinning cone columns (SCC) were used to dealcoholise only the Listán Prieto wines to

Table 1. Sensorial analysis results for dealcoholised wines. RO: reverse osmosis; SCC: spinning cone columns.

| Wine	Triangular test	T (°C)	Positive identifications	*p*-value
Discrimination by alcohol content				
Listán Prieto	0 % by RO vs 6 % by RO	20 °C	30/36 (83 %)	< 0.001
Cabernet Sauvignon	0 by RO % vs 6 % by RO	20 °C	20/36 (56 %)	< 0.01
Listán Prieto	0 % by SCC vs 6 % by SCC	20 °C	29/36 (81%)	< 0.001
Discrimination by dealcoholisation method				
Listán Prieto	0 % by RO vs 0 % by SCC	20 °C	26/36 (72 %)	< 0.001
Listán Prieto	6 % by RO vs 6 % by SCC	20 °C	32/36 (89 %)	< 0.001

0.5 and 6.0 % (v/v) of ethanol content. Ethanol removal was performed when the malolactic fermentation of the wines had finished. After this, 2 g/L of oenological tannin and concentrated grape must with 25 g/L of residual sugar were added to the beverages to correct their composition. Before bottling, to avoid microbiological deterioration of the beverages, 180 mg/hL and 200 mg/L of sorbate and dimethyl dicarbonate was added respectively. The obtained beverages were subjected to a sensory analysis in a triangle test based on the methodology published by Roessler *et al.*[4]. The sensory analysis was performed by a trained professional panel to determine whether the tasters were able to distinguish the wines. The preference ranking was analyzed using the Friedman test and the mean separation was performed using FPLSD (Fisher's Protected Least Significant Difference) for non-parametric data. The second objective was to determine which wine was preferred by the panelists who had correctly identified the different wines. In addition, a descriptive analysis was conducted on the wines to determine their visual, aromatic and gustatory qualities, including their acceptability (hedonic quality). For this, an unstructured guide from 0 to 15 was used, in which 0 determined the absence of the attribute and 15, a maximum intensity of the attribute. The variables were subjected to an analysis of variance (ANOVA). The significance of the differences was determined by Tukey's test (p ≤ 0.05).

■ Results

The judges were able to significantly discriminate the Cabernet Sauvignon and Listán Prieto dealcoholised wines by reverse osmosis (RO) and spinning cone columns (SCC) in the triangular tests (Table 1).
The preference test results indicated the following: the judges significantly preferred the Cabernet Sauvignon wines which had been dealcoholised to an ethanol content of 6.0 % (v/v) by RO, while the least preferred was the Listán Prieto wine, which had been dealcoholised to an ethanol content of 6.0 % (v/v) by SCC (Figure 1a). Cabernet Sauvignon wine dealcoholised to 6.0 % (v/v) by RO was associated with a high degree of sweetness, while

Listán Prieto wine dealcoholised to 6.0 % (v/v) by SCC was associated with high acidity (Figure 2b). Regarding Listán Prieto wines, the judges significantly preferred the wines dealcoholised by RO to those dealcoholised by SCC (Figure 1b); the preferred samples corresponded to Listán Prieto wines dealcoholised by RO up to an ethanol content of 6.0 % (v/v). The least preferred wines were Listán Prieto wines dealcoholised by SCC to an ethanol content of 6.0 % (v/v) (Figure 1b). Listán Prieto wines dealcoholised by RO to 6.0 and 0.5 % were related to sweetness and aromatic intensity respectively (Figure 2b).
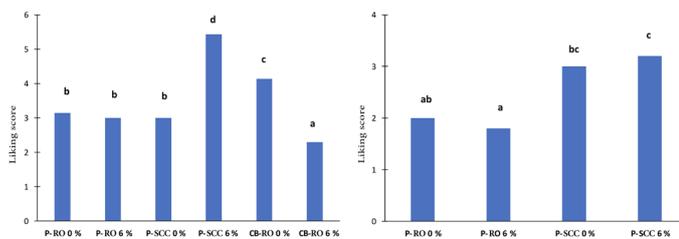

Figure 1. Two-way ANOVA of professional liking scores. a) the beverage samples were analysed simultaneously, and b) the beverages were analysed separately for the Listán Prieto variety. RO: reverse osmosis; SCC: spinning cone columns; P: Listán Prieto; CB: Cabernet Sauvignon. Means with the same letter within the bar chart are not significantly different (FPLSD test (rank), α = 5 %). Beverages were categorized from 1, most preferred, to 6 (for Fig. 1a) and 4 (for Fig. 1b), least preferred.

Regarding the sensory attributes perceived by the judges, differences were only found in the acidity level of the beverages, which depended on the ethanol removal technique (Figure 2a). Listán Prieto wines dealcoholised to an ethanol content of 0.5 and 6.0 % (v/v) by SCC were higher in acidity than Cabernet Sauvignon and Listán Prieto wines dealcoholised to 6.0 % (v/v) by RO (Figure 2a). Regarding hedonic quality, Listán Prieto and Cabernet Sauvignon wines dealcoholised to an ethanol content of 6.0 % by RO were considered to be higher in acceptability than the dealcoholised wines by SCC and the Listán Prieto wines dealcoholised to an ethanol content of 0.5 % (v/v) by RO.

According to the results of the principal component analysis (PCA), Listán Prieto wines dealcoholised to an ethanol content of 0.5 % (v/v) by SCC were positively related to bitterness, astringency and red fruits, whereas Cabernet Sauvignon and Listán Prieto wines dealcoholised at 6.0 % (v/v) by RO were directly related to sweetness and acceptability. Listán Prieto wines dealcoholised to an ethanol content of 6.0 % (v/v) by SCC were positively related to acidity and negatively related to acceptability, whereas Cabernet Sauvignon and Listán Prieto wines dealcoholised to an ethanol content of 0.5 % (v/v) were positively related to aromatic intensity.

■ Conclusions

The dealcoholised wines were characterised by medium aromatic intensities, high levels of acidity,
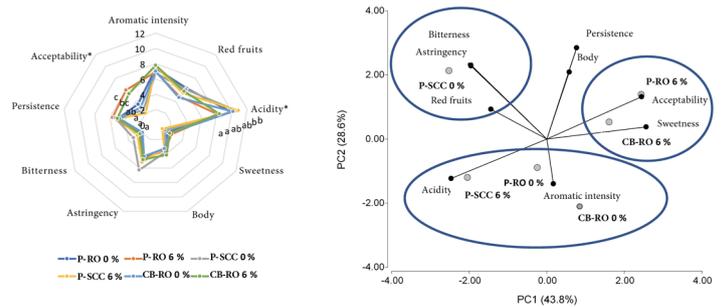
Figure 2. Multiple comparison of sensory attributes perceived by judges in the sensory analysis and principal component analysis of the sensory attributes of wines subjected to dealcoholisation by reverse osmosis (RO) and spinning cone columns (SCC). RO: reverse osmosis; SCC: spinning cone columns; P: Listán Prieto; CB: Cabernet Sauvignon. 0 %: 0.5 %. *Means with same letter within the bar chart are not significantly different (Tukey test, α = 5 %).

low body, and very low sweetness and bitterness. The sensory analysis revealed that the professional panel tended to prefer the wines which had been dealcoholised by reverse osmosis (RO) to those dealcoholised by spinning cone columns (SCC). The acidity level was the only attribute that varied significantly among wines. SCC produced dealcoholised wines with high acidity compared to those with a 6.0 % (v/v) ethanol content by RO, which were correlated with a high hedonic quality and sweetness. These results are important, because they can contribute to providing the wine industry with an alternative means of producing non-alcoholic wine. In addition, SCC is an expensive technology to date and RO equipment can be rented by wineries and cooperatives, thus making this technology available to small wine-producers and thereby diversifying their production. ■

Rodrigo Loyola García[1], Gastón Gutiérrez-Gamboa[1,2], Marcela Medel-Marabolí[3], Irina Díaz-Gálvez[1]
1 Facultad de Ciencias Agrarias, Universidad de Talca, Chile.
2 Instituto de Investigaciones Agropecuarias, INIA Raihuén, Casilla 34, San Javier, Chile.
3 University of Chile, Santiago, Chile.

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