Effect of ion exchange resins on white and red wine pH: Impact on wine sensory characteristics

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ABSTRACT

The pH control during winemaking is a fundamental parameter by their influence on colour, freshness and to achieve wine microbiological stability. The application of ion exchange resins for wine acidification is based on ability of exchanging ions fixed on functional groups, namely by exchanging cations, such as potassium, with hydrogen ions. Nevertheless, there is an important lack of knowledge on the impact of this operation on wine sensory characteristics. Therefore, the aim of this work was to evaluate the effect of cation exchange resins, on wine pH control and to evaluate their impact on wine sensory quality at industrial scale. In this study a white and a red wine, both from the Douro Valley demarcated region, 2015 vintage, were used. The ion exchange resin treated wine was almost 20% from total white wine volume and almost 30% from total red wine volume. The results obtained in the present study indicated that there were no considerable changes in sensory attributes, although a slight improvement in the aroma and taste, as a result of the ion-exchange pH adjustment. Therefore, the application of ion exchange resins process to wine could be an interesting tool for white and red wine pH adjustment, without interfering with wine sensorial quality.

1. INTRODUCTION

Wine pH and acidity control during winemaking is vital for maintaining the wine quality during storage. The most common acidify correction performed in wineries is addition of natural tartaric acid; however, in some cases, this operation increases the risks of potassium bitartrate precipitations [1, 2]. Resin-based ion exchange have been investigated to adjust wine acidity and pH since the 1950s [3]. However, ion-exchange resin technology is accepted for the wine pH reduction only from 2000, according to the OIV Resolution 43/2000 [1]. The most use ion exchange resins involves cation-exchange resins in the H^+ form, for increasing acidity and removing K^+ from wine. To adjust wine pH, a certain amount of treated wine by ion exchange resins is mixed with the untreated wine [4]. According to OIV [5], treatment must not lower the wine pH below 3.0 and the decrease should not exceed 0.3 pH units. Anion exchangers are not allowed by the OIV [3] due to the negative effects on the wine sensory quality [6, 7]. So, the aim of this study was to evaluate, at industrial scale, the effect of cation exchange resins on wine pH control and consequently their impact on wine sensory quality, in white and red wine from the Douro Valley demarcated region, 2015 vintage.

2. MATERIAL AND METHODS

Wine characteristics: A young white wine and red wine from Douro Valley Demarcated Region, vintage 2015, was used. Chemical characteristics of white wine and red wine were as follow, respectively: Alcohol content 13.00% and 12.00%, titratable acidity 5.10 g/L and 4.87 (expressed as tartaric acid), volatile acidity 0.27 g/L and 0.38 g/L (expressed as acetic acid) and pH 3.32 and 3.61.

Experimental design: Treatments using cation exchange resins pH-Stab/AEB laboratory, was performed in a winery at industrial scale, being the treated wine almost 20% from the total volume for the white wine and 30 % of the total volume for the red wine. All experiments were run in duplicate.

pH and titratable acidity: Wine pH and titratable acidity (tartaric acid in g/L) were determined according OIV [8].

Mineral composition: Wine mineral composition, potassium, calcium and magnesium were measured by atomic absorption flame spectrophotometry, according to the methods described by OIV [8].

Sensory analysis: A trained panel of 7 members was used for sensory analysis. Samples were stored at appropriate light and temperature conditions, and were presented to panellists in tasting glasses, marked with three-digit numbers, in a randomised order. Fifteen attributes were selected: visual (*limpidity, colour*), aroma (*aroma intensity, fruity, floral, vegetable, oxidised, chemist*) and taste (*sweetness, bitterness, acidity, flavour intensity, body, balance, persistence*). The attributes were quantified using a five-point intensity scale [9], in individual booths [10] and according to standardised procedures [11].

Statistical analysis: Data are presented as means ± standard deviation. Physicochemical and sensory data were statistically tested by analysis of variance (ANOVA) using the Statistica 7 software (Statsoft, Tulsa, Oklahoma, USA). Tukey honestly significant differences test was applied ($p < 5\%$) for physicochemical data and Duncan test for sensory analysis data ($p < 5\%$).

RESULTS AND DISCUTION

2.1 Effect of ion exchange resins on white and red wine pH, titratable acidity and mineral composition

As expected ion exchange resin treatment lowered the pH of white wine, namely from 3.32 to 3.10 and the pH of red wine from 3.61 to 3.31 as shown in table 1. Titratable acidity increased, in both wines, after ion exchange resin treatment, as compared to the control wine, due to the increased hydrogen content of the pH-adjusted wines.

Table 1. pH and titratable acidity of the control wines and wines after cation exchange resin treatment (mean ± SD).

	White Wine		Red Wine	
	pH	Titratable acidity (g of tartaric acid/L)	pH	Titratable acidity (g of tartaric acid/L)
Control	3.32 ± 0.00[a]	5.10 ± 0.29[a]	3.61± 0.00[a]	4.87±0.31[a]
Resins	3.10 ± 0.00[b]	6.15 ± 0.48[b]	3.31±0.00[b]	6.58 ± 0.08[b]

Means within a column followed by different letter are significantly different ($p < 0.05$).

Ion exchange resin lowered potassium and magnesium concentration in white and red wine. However, calcium only decreased significantly in red wine treated with ion exchange resin (Table 2).

Table 2. White and red wine mineral composition (potassium, calcium and magnesium of the control wine and wine after cation exchange resin treatment (mean ± SD).

	White Wine			Red Wine		
	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)
Control	770.56±69.64[a]	22.20±1.27[a]	84.22±0.19[a]	1092.68±8.73[a]	52.15± 2.43[a]	86.96± 0.36[a]
Resins	473.43±24.89[b]	19.45±0.92[a]	71.72±0.83[b]	696.93±1.99[b]	31.57± 2.42[b]	51.67±0.30[b]

Means within a column followed by different letter are significantly different ($p < 0.05$).

The decrease observed in pH and potassium concentration of both wines indicated that ion exchange resin was effective in exchanging potassium for hydrogen.

2.2 Effect of ion exchange resins on white and red wine sensory characteristics

After white and red wine sensory analyses no significant differences were observed among the wine treated with ion exchange resins and the control, for all the wine attributes evaluated. However, it was observed that the white wine treated with ion exchange resins was more scored for attributes *flavour intensity*, *fruity flavour* and *persistence* and the red wine treated with ion exchange resin was more scored for the attributes *red fruits aroma* and *red fruits flavour* and for the attributes *floral aroma* and *floral flavour* (Figure 1).

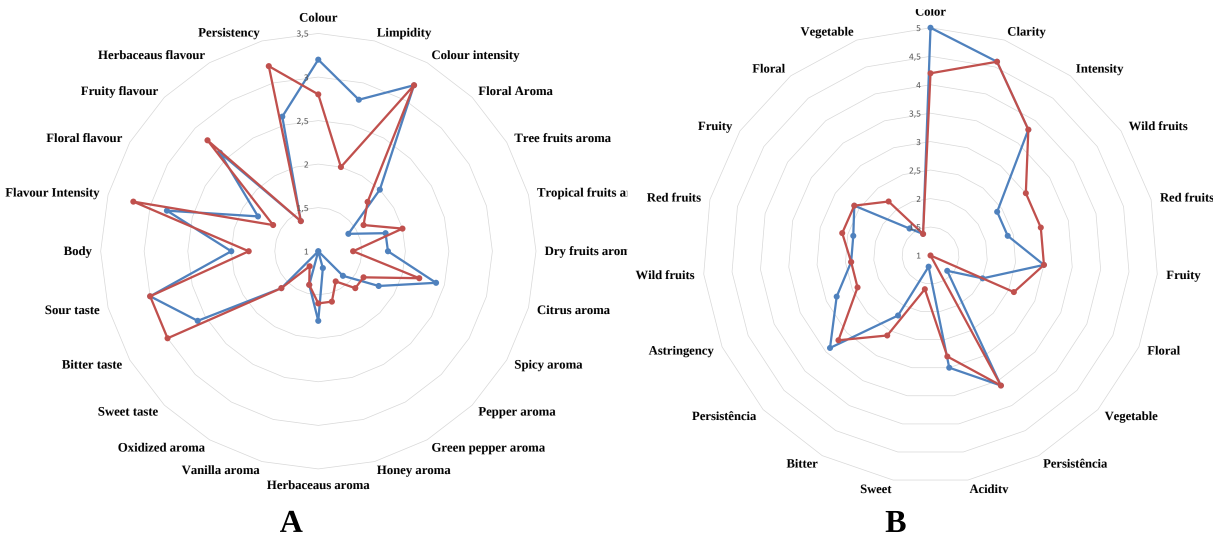

Figure 1. Sensory profile of the white wine (**A**) and red wine (**B**) treated with ion exchange resin (red-line) and control wine (blue-line).

3. CONCLUSIONS

Results showed, as expected, that ion exchange resin treatment lowered the pH of white and red wine and consequently increased the titratable acidity of both wines.

Sensory analysis revealed that wine treatment with cation exchange resin to adjust the wine pH was not significantly different from the control wine. So, results from this work showed that the use of ion exchange resin to adjust wine pH from white or red wine could be a good solution.

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