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Ethanol Vapours to Complement or Replace Sulfur Dioxide Fumigation of Table Grapes

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Abstract

Recent studies have shown that dipping table grapes in ethanol solutions at harvest improved storage of the fruit. We report here the first results obtained by treating 'Chasselas' table grapes (*Vitis vinifera*) with ethanol vapours over the storage period. We tested the effect of ethanol at 0, 4 and 8 g/kg fruit during cold storage for 2, 4 and 6 weeks. We measured berry shatter, stem browning, *Botrytis* rot incidence and sensory appreciation by tasting panels. Ethanol vapours reduced *Botrytis* rot incidence and berry shatter, but hastened stem browning. Sensory analyses did not detect any differences between treatments.

INTRODUCTION

Postharvest applications of ethanol have been shown to influence ripening and senescence (Podd and Staden, 1998), reduce decay (Gabler and Smilanick, 2001), kill insect contaminants (Dentener et al., 1998) and reduce physiological disorders in horticultural products. Table grapes are routinely treated with sulfur dioxide (SO₂) to reduce the incidence of postharvest decay during storage and transportation, however SO₂ treatment may cause damage to the grapes and result in sulfite residues that are unacceptable to some consumers.

Application of ethanol to table grapes by dipping has been shown to effectively improve storage, mainly by limiting *botrytis* growth (Lichter et al., 2002). However, when applied commercially, liquid postharvest treatments have the potential to spread contaminants and cause osmotic damage. We have therefore investigated the efficacy of ethanol to control rots when applied as a vapour within grape packages. Being naturally derived, ethanol is anticipated to be suitable for organic food production.

MATERIALS AND METHODS

'Chasselas' grapes were picked in a local vineyard (Montauban, France) on the 24th of September 2001, packed in 6 kg wooden crates and stored at 0 °C. On the 25th of September, the experiment was set-up as follows, including six treatments: 1) control; 2) one half SO₂ pad which was named "SO₂ (0.5)"; 3) ethanol 4 g/kg "EtOH (4)"; 4) ethanol 4 g/kg + half SO₂ pad "EtOH (4) + SO₂"; 5) ethanol 8 g/kg "EtOH (8)"; and 6) ethanol 8 g/kg + half SO₂ pad "EtOH (8) + SO₂". There was an additional treatment using the full SO₂ pad "SO₂ (1)", to simulate commercial treatment. The crates were stored at 0 °C for 0, 2, 4 and 6 weeks. The experimental unit was a 6 kg crate, replicated 3 times for each treatment and storage duration. Ethanol was placed in a small plastic tray (11 x 10 x 5 cm) with vermiculite to hasten evaporation (volume of vermiculite equal to the volume of ethanol). The tray was placed in a corner of the crate, and the crates were over-wrapped with two plastic bags (polyethylene). At the end of each storage period, the bags were

removed and crates were left at 8 °C for half an hour to limit condensation on the fruit and then transferred to ambient temperature. Quality assessments were performed 3 days later. *Botrytis* rot incidence was visually assessed by counting the number of affected berries per cluster on all the clusters in each crate. Berry shatter was assessed by shaking twice one cluster randomly chosen from each crate. (Ahumada et al., 1996). Shatter was expressed as the percentage of fallen berries, by weight. Stem browning was visually assessed using the following scale:

Score	% of stem browning
0	< 10%
1	10 - 30%
2	30 - 50%
3	50 - 70%
4	70 -90%
5	> 90%

Stem browning was assessed on approximately six clusters per crate located an equal distance from the ethanol tray and the edge of the crate. These positions were chosen because we observed a decreasing gradient of stem browning from the ethanol source to the edge of the crate. The sensory analyses were performed with consumer panels consisting of 21 panellists for each session. All samples were designated by 5 digit codes. The 3 replicates of each sample were randomly distributed among the panellists. Each panellist tasted the seven samples once, before tasting again and scoring according to a hedonic scale (Poste et al., 1991).

RESULTS AND DISCUSSION

Ethanol vapours limited *Botrytis* incidence, with some additive effects when used in conjunction with half SO₂ pads (Fig. 1). However, it should be noted that the bunches were not heavily infected (no artificial inoculation) and that the only significant differences were observed between controls and other treatments after 4 and 6 weeks of storage. This confirms the results of Lichter et al. (2002).

When comparing the treatment effects on berry shatter, we observed that our assessment by shaking only one bunch per crate was not adequate, as there were large variations within some treatments, e.g. SO₂ (full pad) (Fig. 2). However there seemed to be a trend showing that ethanol vapours alone did reduce shatter. It has to be noted that ‘Chasselas’ grape is not normally prone to shatter, however this was evaluated to extrapolate to more susceptible cultivars such as ‘Thompson Seedless’. The strong drawback of the use of ethanol vapours was stem browning. This was obviously dependent on the ethanol concentration and was not counter-balanced by SO₂ (Fig. 3). Stems of bunches close to the ethanol source were browner than those close to the opposite edges of the crate (data not shown). Lower ethanol doses and a different system to apply ethanol vapours will be tested in subsequent year’s experiment.

Finally, we tested the ability of a taste panel (university students) to differentiate between the various treatments. The hedonic scale was found to be suitable for a non-specialist panel. None of the treatments affected the appreciation rating by this panel (Fig. 4).

We ran another small experiment in which grapes were treated with ethanol vapours (3, 9 and 27 g/kg) for smaller periods (1 and 5 hours) during the day following the cold storage. We did not get any significant effect after three days at 20 °C (data not shown).

CONCLUSION

Ethanol vapours alone or in combination with reduced SO₂ rates have shown some promising effects for storage of table grapes. However, the negative effects of these

vapours on stem browning have to be overcome at least with 'Chasselas' grapes. Lichter et al. (2002) did not report increased stem browning, indicating that dipping may be more appropriate or that other cultivars may be less sensitive to stem browning.

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Figures

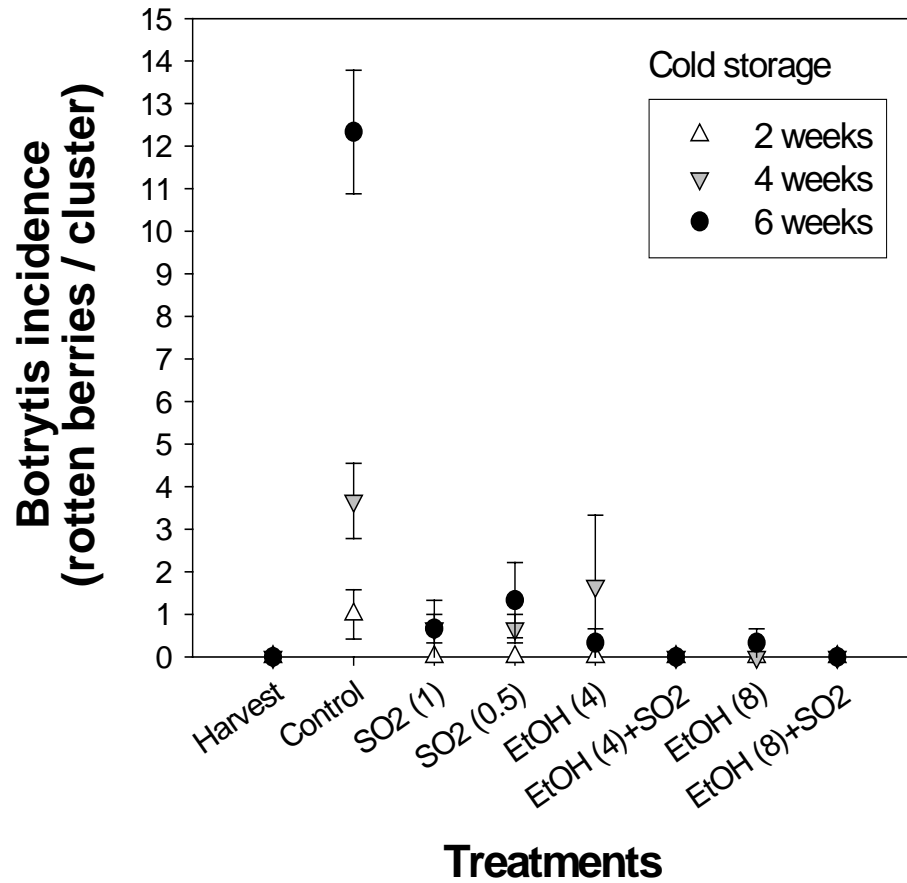
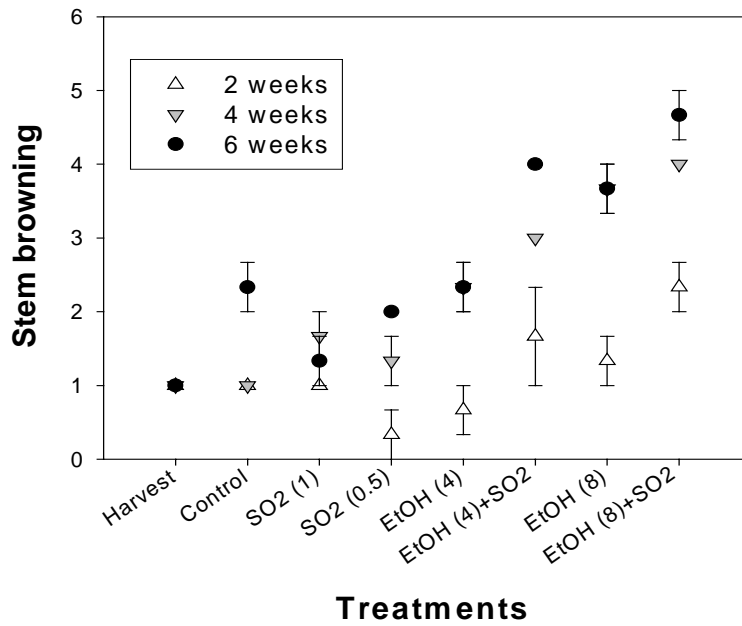
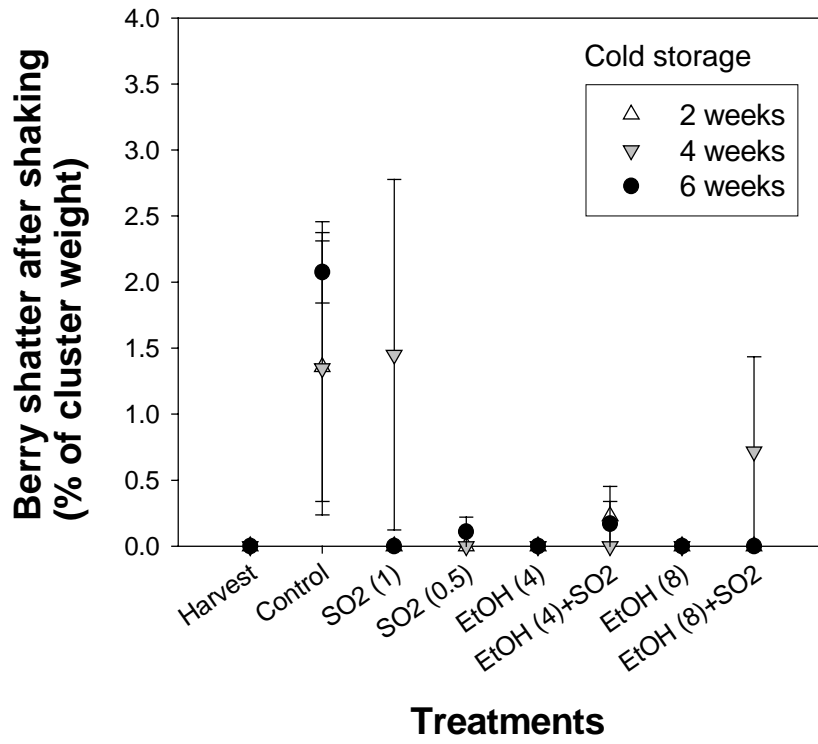


Fig. 1. *Botrytis* incidence as a function of different treatments combining ethanol vapours and SO₂. After cold storage the fruit was kept 3 days at ambient temperature before visual assessment. Error bars show SE.



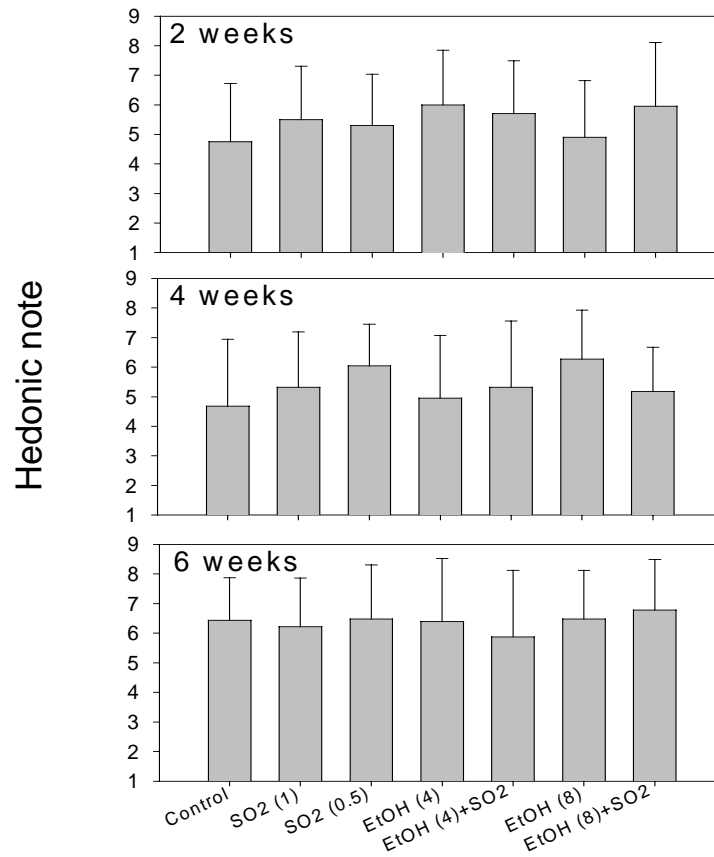


Fig. 4. Appreciation by consumers as a function of different treatments combining ethanol vapours and SO₂. After cold storage the fruit was kept 3 days at ambient before assessment. "1" was for "dislike extremely" and "9" for "like extremely". Error bars show SE.