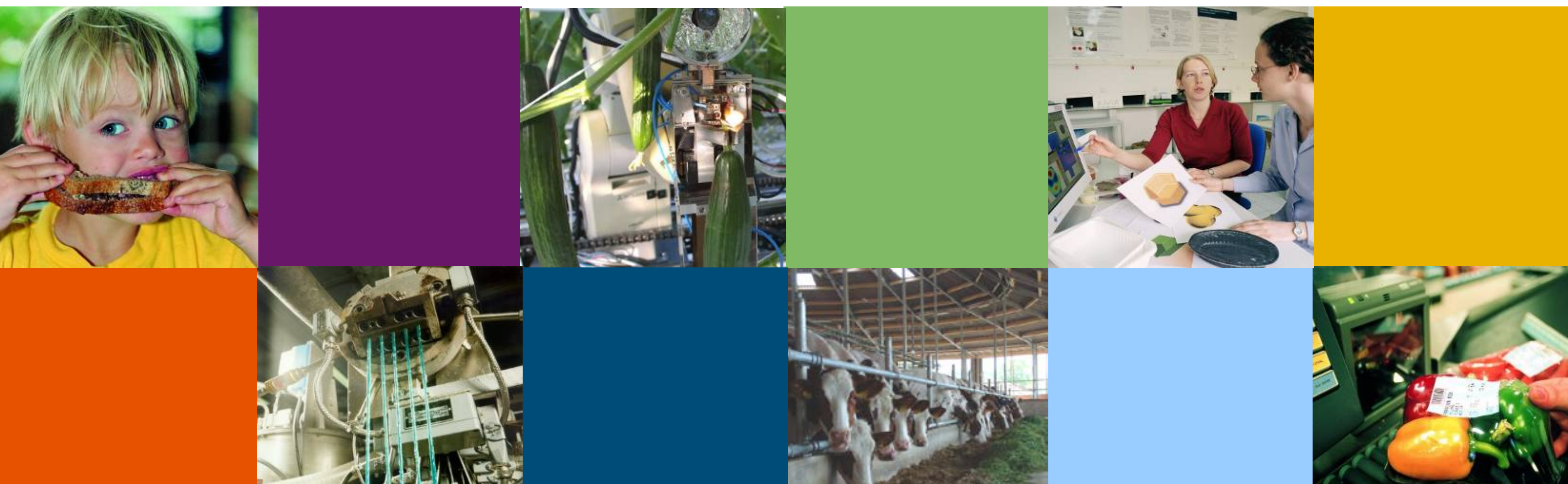
Effect of 12% CO2 during storage on quality of Allison table grapes from Spain

GreenCHAINge WP1 – Table Grapes

Manon Mensink
Eelke Westra

Report 1727



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Author(s)	Manon Mensink, Eelke Westra
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Wageningen Food & Biobased Research
P.O. Box 17
NL-6700 AA Wageningen
Tel: +31 (0)317 480 084
E-mail: info.fbr@wur.nl
Internet: www.wur.nl/foodandbiobased-research

Abstract

Table grapes produced in South Africa and South America are transported in Reefer containers to the Netherlands. This takes two to three weeks' time, depending on the route and the transport company.
Usually SO_2-pads are used to suppress development of fungal infection during long term transport. The use of SO_2-pads is increasingly under pressure. In literature several alternatives have been presented.
Previous research (ExperiCo, 2015) showed elevated levels of CO_2 to give promising results. However, finding the right concentration is a trade-off between Botrytis suppression and the evolution of an off taste.

The goal of this study:

> To investigate whether elevated levels of CO_2 can suppress Botrytis infection in Allison seedless table grapes from Spain during storage without causing off flavour.

Allison seedless table grapes from Spain (week 45 in 2016), suffered a lot from fungal infection. This fungal infection was already visible in the starting material.
High CO_2 applied in a flow through system (12% CO_2 and 18% O_2) could supress fungal infection during storage to certain extent.
The results of this experiment are promising. However, since infection levels were very high already at the start of the experiment, it has to be repeated before final conclusions can be drawn concerning the effectivity of the treatment and the effect on taste.

Content

1 Introduction

Table grapes produced in South Africa and South America are transported in Reefer containers to the Netherlands. This takes two to three weeks' time, depending on the route and the transport company.
Usually SO_2-pads are used to suppress development of fungal infection during transport. The use of SO_2-pads is increasingly under pressure and in literature several alternatives have been presented.
Previous research (Experico, 2016) showed that elevated levels of CO_2 gives promising results. However, finding the right concentration of CO_2 forms a trade-off between Botrytis suppression and the evolution of an off taste.

To give Botrytis the opportunity to germinate and start the infection, Allison seedless table grapes were stored for two weeks at 3.5°C and a high relative humidity.
The effect of 12% CO_2 and 18%O_2 in a flow through system was tested in comparison to the application of SO_2-pads on top of punnets packed in a plastic bag.
As reference for method of application in both systems an air-control was included, resulting in 4 treatments (Table 1).

Table 1 Diagram of the treatments in the experiment

	Regular storage	CA-storage
Controls	Air	Air
Treatments	SO_2	CO_2

1.1 Goal

To investigate whether elevated levels of CO_2 can suppress Botrytis infection in Allison seedless table grapes from Spain during storage without causing an off flavour.

1.2 Research questions

The results of this study will give an answer to the following questions:

- What is the level natural Botrytis infection in these grapes, as tested in the HotBox?
- Is natural Botrytis infection level enough to test anti Botrytis treatments?
- Can 12% CO_2 reduce or prevent the growth of Botrytis during storage and retail?
- Can an off flavour be detected after storage?

2 Methods

2.1 Experiment setup

2.1.1 Randomizing punnets

The grapes arrived at Wageningen Research in week 45 in 2016. The grapes were delivered in cardboard boxes, each containing ten 500 g punnets, in one layer.
To even out potential differences in quality between boxes, the punnets for each treatment were put together from different boxes. Each treatment consisted of ten punnets *in duplo*.

Figure 1 Punnets packed in plastic with two SO_2 pads on top

2.1.2 Storage treatments for transport simulation

To simulate transport, the grapes were put in cold storage for two weeks. The grapes were stored in punnets, at 3.5°C in regular storage and in the flow through system.
In the regular storage facility, RH was kept high, but not controlled. The first and the last box of the pile in the cold store were dummy boxes, containing empty punnets. The SO_2 treated punnets were packed in a plastic bag with two sheets for slow SO_2 release.
In the flow-through system, four cylinders with ten punnets each were used. Two cylinders were used for regular air (0% CO_2 and 21% O_2) and two cylinders for applying 12% CO_2 and 18% O_2. The air was humidified by passing it through a bottle filled with water. After storage, quality was visually inspected. Subsequently, the punnets underwent a the retail simulation followed by the final inspection.

Figure 2 Punnets in the flow through system (in the picture Thompson seedless) before closing the containers

2.1.3 Starting material

Ten punnets were used to determine starting quality. After visual inspection they underwent a retail simulation followed by the final inspection.

2.1.4 Retail simulation

To simulate the retail phase, punnets were stored under shelf life conditions at 18°C, 60% RH and 12 hr/day a light intensity of 12$\mu mol \cdot m^{-2} \cdot s^{-1}$ for 7 days.

Figure 3 Impression punnets in the HotBox and starting material in the retail simulation (in the picture Thompson seedless)

2.1.5 HotBox-test

To evaluate the fungal infection grade of the starting material, ten extra punnets were stored at 100% RH at 18°C and 12 hr/day a light intensity of 12$\mu mol \cdot m^{-2} \cdot s^{-1}$ for 7 days. Afterwards, a final inspection took place.

2.2 Quality inspection

2.2.1 Visual inspection

During this non-destructive visual inspection, the punnets stayed closed. First an overall impression is determined by giving a mark from 5 (excellent) to 1 (very bad quality):

5: excellent
4: small comment, good saleability
3: clear remark, still saleable
2: unsaleable
1: unsaleable and clearly very bad

This overall impression mark is a subjective measure. The number of visible bad berries are counted and separated into several classes (cracks, brown spots, fungal infection and SO_2 damage).

Visual inspection was carried out on the first day after storage and on day 4 of the retail simulation.

In the figures, the number of poor, inedible berries is used as quality measurement.

2.2.2 Final inspection

For the final inspection, all berries are taken from the stalk and distributed over several fractions:

1. Loose berries: total of edible and inedible berries
2. Edible berries
3. Inedible berries:
    a. Berries showing a brown attachment mark
    b. Berries showing fungal infection
    c. Berries with other defects, like brown spots, cracks and SO_2-damage
4. Stem

The weight is taken from all fractions. In the figures, the percentage of good, edible berries and poor, inedible berries in the several fractions, as determined by weight, were used as a quality measure.

3 Results and discussion

3.1 Starting material

The quality of the starting material was evaluated at arrival and after retail simulation.
At arrival, ten punnets were visually inspected, resulting in a (subjective) overall impression mark and a number of poor berries.
Figure 4 shows the number of poor berries and the overall impression in the starting material of individual punnets. The poor berries already showed fungal infection. The quality mark of the starting material ranged from 2 to 4, with an average of 2.5.

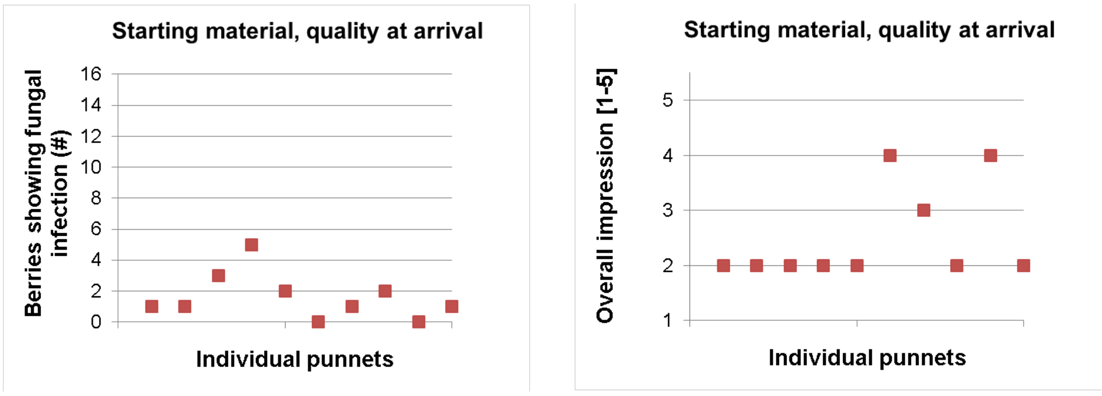

Figure 4 Number of berries showing fungal infection (left) and overall impression (right) of individual punnets at arrival

After the retail simulation, the percentage good, edible berries was calculated, as well as the percentage of berries in the three fractions of inedible berries. Data is shown in Figure 5.

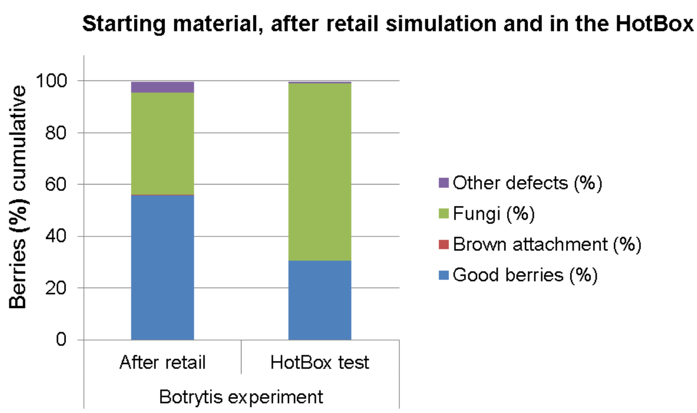

Figure 5 Percentage of berries of the starting material in four quality fractions, after retail simulation and in the HotBox

The grapes mainly suffered from fungal infection after retail simulation. Hardly any other defect could be detected. Almost 40% of all berries showed mould. The grapes from the HotBox treatment showed elevated levels of fungal infection with 70% infected berries (Figure 5).

3.2 After transport simulation

3.2.1 Visual inspection

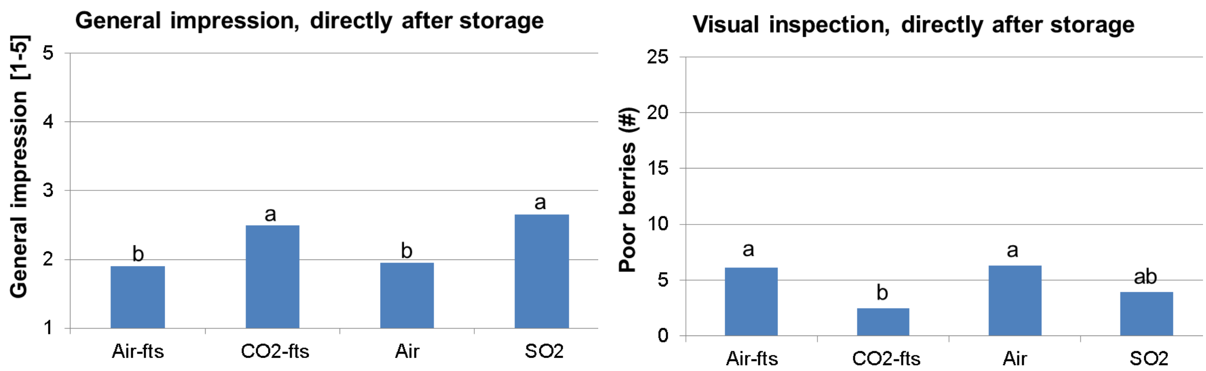

Figure 7: Overall impression (left) and the number of poor berries (right) directly after transport simulation for two weeks at 3.5°C. FTS: flow through system. Bars with corresponding letters do not differ significantly.

Figure 7 shows the overall impression of the punnets directly after transport simulation and the number of poor berries at the moment of visual inspection. Grapes stored in air had a lower impression mark and showed more poor berries than grapes stored in high CO_2. Grapes stored with SO_2-pads had a higher impression mark, but had the same amount of poor berries compared with grapes stored in air.

3.2.2 Final inspection

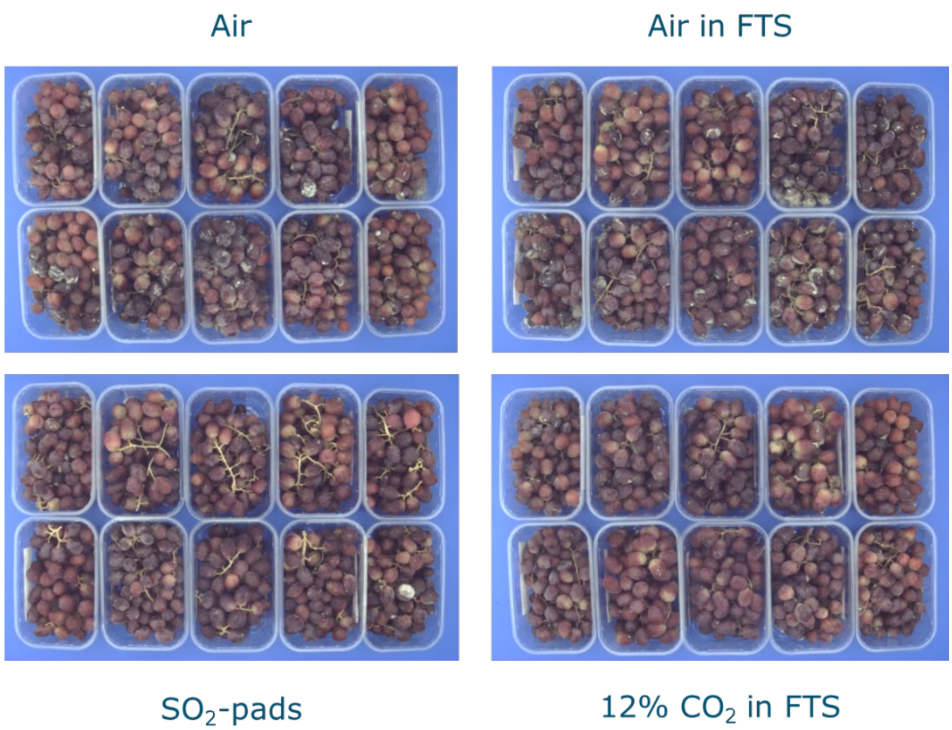

Figure 8 Impression of ten punnets per treatment after two weeks transport simulation and retail simulation. FTS: flow through system

After retail simulation, the grapes appeared to be seriously infected by fungi in all treatments, as can be seen in Figure 8. The grapes were not suitable for consumption and as such, it was not possible to taste the berries. However, during final inspection, differences between treatments could still be detected.

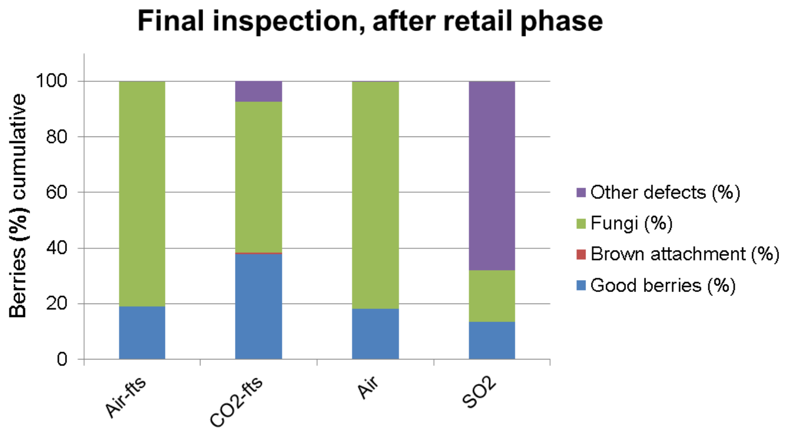

Figure 9 Percentage of berries in the four quality fractions per treatment, after retail simulation. FTS: flow through system

The grapes stored in air showed 80% of infected berries (Figure 9 and Figure 10), independent of the way of storage, flow-through or regular. When stored in high CO_2, the level of infection was significantly lower by about 25% (Figure 10). When stored with SO_2-pads, the infection level was significantly lower, about 20%.
Almost 70% of the berries stored with SO_2-pads showed heavy SO_2-damage, like bleaching and sunken tops. This resulted in significantly less edible berries compared to storage in high CO_2. The amount of edible berries nearly doubled when stored in CO_2 (Figure 10).

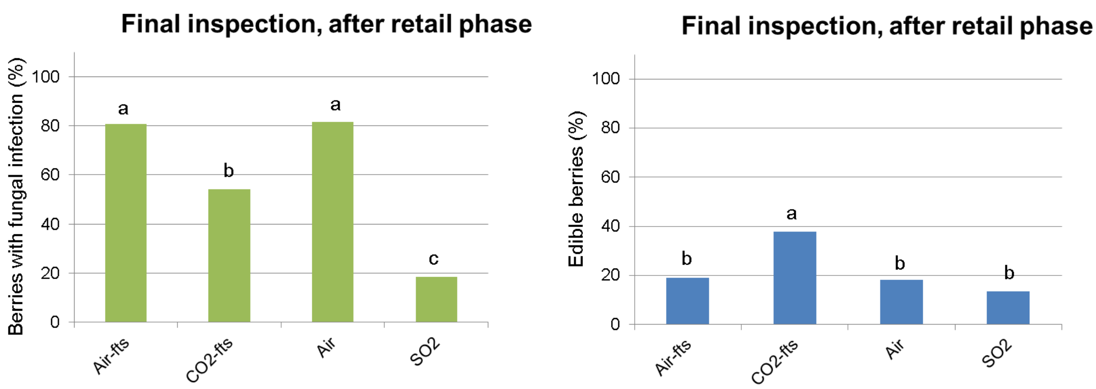

Figure 10 Percentage of berries with fungal infection (left) and edible berries (right) per treatment. Bars with corresponding letters do not significantly differ. FTS: flow through system

4 Conclusions

The results of this study answered the following research questions:

1) *What is the level of natural Botrytis infection in these grapes, as tested in the HotBox?*

The Allison seedless table grapes from Spain in this trial suffered seriously from fungal infection. This fungal infection was already visible in the starting material. After testing in the Hotbox 70% of the berries of the starting material was infected with Botrytis.

2) *Is the natural Botrytis infection level high enough to test anti Botrytis treatments?*

Yes, the infection was in fact too high for a definitive conclusion.

3) *Can 12% CO_2 reduce or prevent the growth of Botrytis during storage and retail?*

High CO_2 applied in a flow through system could suppress fungal infection during storage to certain extent. The infection was lowered with 30%. When stored with SO_2-pads, the infection level was significantly lower, about 20%. However almost 70% of the berries stored with SO_2-pads showed heavy SO_2-damage, like bleaching and sunken tops. This resulted in significantly less edible berries than when stored in high CO_2.

4) *Can an off flavour be detected after storage?*

The grapes were not suitable for consumption. Therefore it was not possible to taste the berries for any off taste.

The results of this experiment are promising. However, since infection levels were very high, this experiment has to be repeated before final conclusions can be drawn concerning the effectivity of the treatment and its effect on taste.

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