South African Avocado Growers' Association Yearbook. 2001. 24:45, 47-48

Modification of ethylene-induced ripening of 'Hass' avocados by an ethylene absorbing filter

Deirdre M. Holcroft and Liezl Kruger
Department of Horticultural Science, University of Stellenbosch,
Private Bag X1, Matieland 7602
E-mail: dmh@akad.sun.ac.za

ABSTRACT

The effect of ethylene on the quality of 'Hass' avocados was evaluated by subjecting fruit to air, air with an ethylene absorbing filter, 10 ppm ethylene in air and 10 ppm ethylene with a filter, applied using a flow through system. Applied ethylene had little effect on firmness of intact fruit measured with a densimeter after 28 days at 4.5°C, or a further 5 days at 20°C. However when the skin was removed, differences in flesh firmness were clear with fruit stored in air being firmer than ethylene-treated fruit. Although the filter only reduced the ethylene concentration by 2-3 ppm, it resulted in 53% of the fruit being considered edible, compared to only 17% of fruit exposed to 10 ppm ethylene.

INTRODUCTION

Avocados are climacteric fruit and produce high rates of ethylene when ripe i.e. > 100 µL/kg.h at 20°C (Kader and Arpaia, 1999). Ripening of the fruit can be stimulated by ethylene applications of 10-100 ppm at 15-18°C (Arpaia, 1998). This sensitivity to ethylene means that care must be taken to prevent exposure to ethylene during storage and transport. Controlled atmospheres assist in reducing the synthesis and action of ethylene, but Kader (1997) recommended that ethylene concentrations be kept below 1 ppm even in controlled atmosphere storage.

Our objectives in this experiment were to evaluate the effect of removing ethylene using an absorbent in a simulated shipping environment, and evaluate the effect on respiration rate, ethylene production and fruit quality. Since flow through system was used to measure respiration and ethylene production, it was necessary to supply physiologically active ethylene concentrations and test the effect of the use of these filters on fruit quality.

MATERIALS AND METHODS

'Hass' avocados were subjected to air or 10 ppm ethylene in air applied using the flow through system. Six of the 12 replicates of both air and ethylene treatments had an ethylene absorbing filter (manufactured and supplied by BTC Products) attached to the inflow, while the other six replicates did not. Consequently, there were four treatments, namely, air, air + filter, C_2H_4 and C_2H_4 + filter, each consisting of 6 reps with 10 fruit per rep.

Since there were practical difficulties in obtaining a gas mixture of 1-5 ppm ethylene in air, it was necessary to use 10 ppm ethylene.

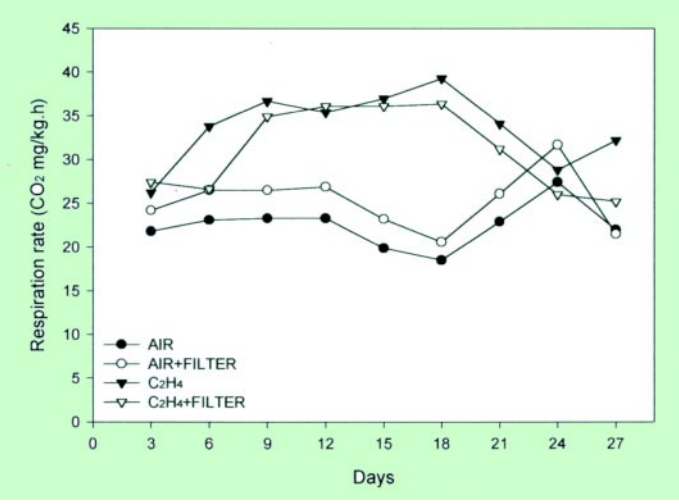

Figure 1 Respiration rates of 'Hass' avocados stored at 4.5°C and treated with air, air plus an ethylene absorbing filter, 10 ppm ethylene or ethylene plus a filter.

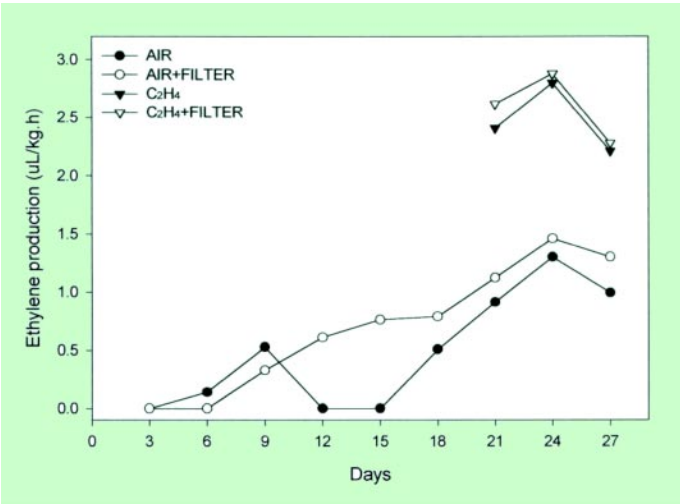

Figure 2 Ethylene evolution of 'Hass' avocados stored at 4.5°C and treated with air, air plus an ethylene absorbing filter, 10 ppm ethylene or ethylene plus a filter.

The flowboard was connected to 10 ppm ethylene in air for a limited time per day, i.e. 6 hours a day for the first 9 days, and thereafter for 3 hours a day for 10 days. For the rest of the time the flowboard was connected to air. After 19 days, the flowboard was transferred to air alone for the remainder of the storage period. The efficiency of the filters in absorbing ethylene was measured by measuring the outflow from the filters using a gas chromatograph.

Table 1 Percentage fruit considered edible after 28 days at 4.5°C and 5 days at 20°C.

	Treatment	Percentage edible fruit
	Air	90
	Air + filter	80
	C_2H_4	17
	C_2H_4 + filter	53

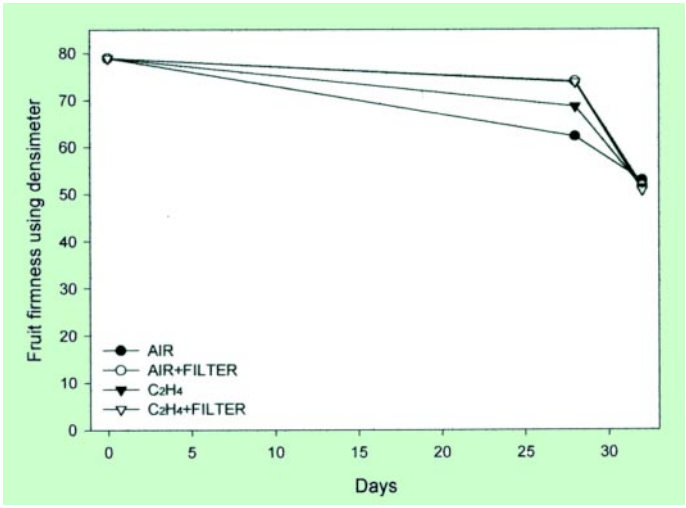

Figure 3 Firmness of intact 'Hass' avocados stored at 4.5°C and treated with air, air plus an ethylene absorbing filter, 10 ppm ethylene or ethylene plus a filter.

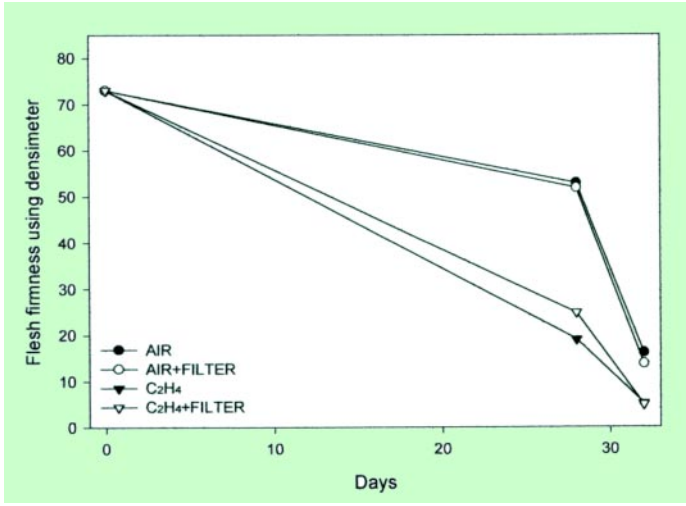

Figure 4 Flesh firmness, i.e. without skin, of 'Hass' avocados stored at 4.5°C and treated with air, air plus an ethylene absorbing filter, 10 ppm ethylene or ethylene plus a filter.

Fruit was stored for 28 days at 4.5ºC, followed by a shelf-life period of 5 days at 20ºC. During this time respiration rates were measured every three days by determining CO_2 evolution with a portable infrared gas analyser. Ethylene evolution from fruit treated with air was measured for the entire storage period, while that from ethylene-treated fruit was only measured after 19 days, when the ethylene application ceased.

Fruit maturity and quality was evaluated initially, after 28 days at 4.5°C, and again after 5 days at 20°C. Fruit maturity was assessed by determining moisture content. Firmness was measured using a densimeter. Densimeter readings were taken on avocados with their skin still intact. 'Hass' avocados tend to have rough skin and thus give inaccurate readings, hence flesh firmness, i.e. firmness of fruit with skin removed, was also recorded. Fruit were cut open and rated for internal storage disorders. This data is presented as edible fruit remaining after storage and shelf life.

RESULTS AND DISCUSSION

The use of ethylene filters reduced the incoming ethylene from 10 ppm to 6-8 ppm. While the benefits of the filter can be seen, we believe the results do not reflect the true potential of filters. The flow rates which were necessary for measurement of respiration were too high for the filters to efficiently absorb ethylene. Also, since we used specially made filters for this experiment, they were smaller than a commercial filter used in a container or coldroom and were of insufficient capacity to absorb the relatively high concentration of ethylene (10 ppm) applied.

Applied ethylene increased the respiration rate of the fruit, though to a slightly lesser extent in C_2H_4 + filter treatments (Figure 1). After the ethylene treatment ceased, the respiration rate of this fruit decreased. The respiration rate of air-treated fruit was consistently lower than ethylene-treated fruit until 24 days of storage. The respiration rate of the fruit in air + filter treatment was slightly higher than in air alone. This effect can be explained by the higher ethylene production in fruit in the air + filter treatment compared to air alone (Figure 2).

Ethylene production from fruit treated with air increased to a maximum of 1.5 µL/kg.h after 24 days at 4.5°C. Similar rates for ethylene production at 3°C and 7°C were measured by Zamorana *et al.* (1994). The ethylene production of fruit that had been treated with 10 ppm ethylene could not be measured for the first 19 days because of the presence of applied ethylene in the system. However, once the flowboard was connected to air, ethylene production was measured. Fruit that had been treated with ethylene (10 ppm) showed higher rates of ethylene production after applied ethylene ceased (ca. 3 µL/kg.h), as expected (Figure 2). Fruit stored in the air + filter treatment produced more ethylene than in air alone. This is more likely from riper or damaged fruit and not a consequence of the filter itself.

The moisture content of the avocados was between 67 and 70%. Firmness of intact fruit decreased after 28 days at 4.5°C (Figure 3). At this stage air-treated fruit were the softest of the four treatments, but these differences were small. After 5 days at 20°C there were no measurable differences between any of the treatments. Densimeter readings taken on flesh i.e after removal of the skin were very different (Figure 4). After 28 days at 4.5°C, ethylene-treated fruit (19.0) was much softer than air-treated fruit (52.9). Fruit from C_2H_4 + filter treatment (24.8) was slightly firmer than ethylene-treated fruit (19.0), but this difference had disappeared after 5 days at 20°C.

Fruit treated with air had the lowest incidence of internal defects, rated as edible fruit, after 5 days at 20°C (Table 1). Fruit treated with ethylene had the highest incidence of disorders, namely only 17% of the fruit were considered edible. The greatest benefit of the filters was on internal fruit quality of ethylene-treated fruit, with 53% being considered edible.

CONCLUSIONS

Despite the less than ideal conditions in this experiment resulting in ethylene reduction of only 2-4 ppm by the use of filters, the advantages of even such slight reductions in ethylene concentration resulted in a reduction in storage disorders when a filter was. In air-treated fruit, where the only source of ethylene is that which is synthesised during ripening, the flesh was considerably firmer and 80-90% of the fruit was edible.

LITERATURE CITED

ARPAIA, M.L. 1998. Optimum procedures for ripening avocados. Management of fruit ripening. *Postharvest Series* 9:12-13.

KADER, A.A. 1997. A summary of requirements and recommendations for fruits other than apples and pears. *CA 97 Proceedings* 3:1-34.

KADER, A.A. and ARPAIA, M.L. 1999. Produce Facts: Avocado. *Perishables Handling Quarterly* 97:15-16.

ZAMORANA, J.P., DOPICO, B., LOWE, A.L., WILSON, I.D., GRIERSON, D. and MERODIO, C. 1994. Effect of low temperature storage and ethylene removal on ripening and gene expression chnages in avocado fruit. *Postharvest Biology and Technology* 4:331-342.