

STORAGE OF LULA AVOCADOS IN CONTROLLED ATMOSPHERE 1970 TEST

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ABSTRACT

One hundred percent of Lula avocados stored in a controlled atmosphere (CA) of 2% O₂ + 10% CO₂ at 45° F. were in acceptable condition after storage for 20 or 40 days. All fruit stored in air were decayed after 40 days at either 45° or 50°. After both storage periods, avocados from CA storage were superior to those from air storage. A temperature of 45° was generally as good or better than 50° for use in CA storage. Decay, external darkening, and percentage weight loss were significantly lower in fruit held in an atmosphere of 2% O₂ + 10% CO₂ than in air.

INTRODUCTION

Tests have been conducted for several years at Miami to develop successful methods of utilizing controlled atmosphere (CA) storage of Florida avocados. Hatton and Reeder (2) initially reported limited success with CA storage of Lula avocados in research conducted in 1965. Successful storage in 1966 of Lula avocados in 1% O₂ + 9% CO₂ at 50° F. was also reported (3).

Prior to 1968, all CA storage tests with avocados were conducted with a closed system in which the atmospheres within the storage chambers were recirculated. In 1968 a test was initiated to evaluate a constant-flow system in order to eliminate any effect from ethylene evolving from the fruit in the storage chambers. Premixed gas was obtained from a commercial source; however, instead of the 1% O₂ + 9.0% CO₂ level which was ordered, the gas received contained 1.2% O₂ + 9.6% CO₂.

Analysis of the gas exhausted from the storage chambers showed an O₂ content of 0.3% to 1.0% and a CO₂ content of 10.0% to 10.5%.

The flow rate of 100 ml/min was not high enough to prohibit the O₂ levels from dropping and the CO₂ levels from rising within the storage chambers due to the respiration of the fruit. Avocados held under the reduced levels of 0.3% to 1.0% O₂ for 30 and 45 days developed 64% and 32% injury, respectively. In the 1965 test (2), several fruit had displayed injury after storage in atmospheres containing 1.0% to 1.5% O₂. Subsequent tests were planned using a constant-flow system containing 2% O₂ so that respiration of

the fruit would not reduce the O₂ level below 1.0% to 1.5% where injury would likely occur. An atmosphere containing 10% to 10.5% CO₂ appeared satisfactory in the 1968 tests, and a level of 10% was considered acceptable for future testing.

MATERIALS AND METHODS

Lula avocados were harvested commercially from a grove in the Homestead, Florida area on February 2, 1970. The fruit was randomized, weighed, and divided into samples of 20 fruits each. Six samples of fruit were placed in chambers containing air, three at 50° F., and three at 45°. Comparable samples of fruit were placed in CA storage chambers at 50° and 45°. All chambers were of 116-liter volume, exclusive of fruit. Premixed gas of 2% O₂ and 10% CO₂ was ordered from a commercial source; however, analysis of the gas received showed 2% O₂ and 9.5% CO₂. The premixed atmosphere was flowed through the CA chambers at a rate of 200 ml/min. Respiration within the chambers altered the atmosphere surrounding the fruit so that the gas which was exhausted contained 2% O₂ and 10% CO₂. The storage temperature used in previous CA research on avocados in Miami was 50°; in this test 45° was used to further reduce respiration levels during storage. Relative humidity, measured with an electric hydrometer, ranged from 95% to 100% in all chambers.

After periods of 20 and 40 days, samples of 20 fruits each were removed from the air and CA chambers at both storage temperatures. Avocados were scheduled to be withdrawn from storage after 60 days; however, malfunctioning of the refrigeration equipment resulted in elevated temperatures shortly after the 40-day storage period, at which time the experiment was terminated. Data were recorded on weight loss, decay, and appearance upon removal from storage. Overall acceptability of the fruit was based on freedom from decay and external discoloration. Fruit considered unacceptable upon removal from storage was recorded and discarded and the remaining sound fruit was placed at 70° F. to soften. The avocados were checked daily to determine the state of softness and data were again recorded on weight loss, decay, appearance and acceptability when the fruit was soft.

Decay and external discoloration ratings were based on the total percentage of aggregate surface area affected: (0) None; (1) Trace, 1%-10%; (2) Slight, 11%-25%; (3) Moderate, 26%-50%; and (4) Severe, over 50%. Avocados with moderate and severe decay or external discoloration were considered unacceptable. Sound avocados, from each sample of fruit when soft, were evaluated by staff members for the presence of any off-flavors.

Statistical analysis of data was made after each storage period by mean separation of the functional analyses of variance and multiple comparisons (1).

RESULTS AND COMPARISON

The results of this test comparing storage of Lula avocados in 2% O₂ + 10% CO₂ and in air at 45° and 50°F. Are summarized in Table 1.

Overall acceptability.—Storage of Lula avocados under a constant flow of 2% O₂ + 10% CO₂ at 45° F. resulted in 100% acceptable fruit. A storage temperature of 45° F. appeared slightly better than 50° for periods of 20 or 40 days although the differences

were significant only in CA after 40 days. No off-flavors were detected in samples of any sound avocados regardless of atmosphere or storage temperature.

Decay.—Decay levels during storage in CA and softening at 70° F. were low, with no significant difference between fruit stored at 45° or 50° for 20 or 40 days. Lula avocados stored in air developed considerable decay at both 45° and 50° after 20 days and all fruit were decayed after 40 days.

Table 1.--Characteristics of Lula avocados after storage for 20 and 40 days in 2% O₂ + 10% CO₂ and in air at 45° and 50° F.^{1/}

Storage atmosphere ^{2/} and temperature °F	Acceptable fruit when soft ^{3/} Percent	Decay after softening ^{3/, 4/} Rating	External darkening when soft ^{4/} Rating	Time to soften at 70°F. Days	Weight loss during storage Percent	Weight loss when soft Percent
Prestorage Air - 70	100	0.25	0.00	6.9	-----	8.2
20 Days						
CA - 45	100a	0.10a	0.35a	4.8a	1.4a	7.1a
CA - 50	95a	0.25a	0.25a	4.5b	1.6a	7.5a
Air - 45	65b	1.25b	2.75b	2.7c	1.7a	6.0b
Air - 50	55b	1.50b	3.50b	2.4d	2.5b	6.0b
40 Days						
CA - 45	100a	0.15a	0.75a	4.6a	1.6a	7.5a
CA - 50	80b	0.90a	0.60a	4.1a	2.4b	7.9a
Air - 45	0c	4.00b	4.00b	---	---	---
Air - 50	0c	4.00b	4.00b	---	---	---

^{1/} Statistical analysis based on 20 fruit per treatment for each storage period. Data followed by different letters were significantly different at the 1% level (Duncan's Multiple Range Test).

^{2/} CA refers to an atmosphere of 2% O₂ + 10% CO₂.

^{3/} Includes fruit which were decayed when removed from storage and discarded.

^{4/} Ratings based on total percentage of aggregate surface area affected: (0) None; (1) 1%-10%; (2) 11%-25%; (3) 26%-50%; and (4) over 50%.

External darkening.—a dark grayish-brown discoloration of the skin was noted in some fruit after storage and subsequent softening. This darkening appeared to be an external symptom of chilling injury. Only a trace of internal chilling injury was noted in any CA-stored fruit. Air-stored fruit exhibiting severe skin discoloration often did show internal damage. No significant difference was found in the amount of discoloration between avocados stored at 45° and 50° F. After 40 days, anthracnose decay on avocados stored in air was so severe that it was difficult to distinguish between discoloration and the decay.

Time to soften.—Lula avocados stored at 45° P. for 20 days softened significantly more slowly when held at 70° than did comparable fruit stored at 50°. After 20 days, avocados stored in CA at both 45° and 50° softened significantly more slowly than did fruit stored in air at either temperature.

Percentage weight loss.—After the 40-day storage period, the percentage weight loss during storage at 45°P. was lower than the weight loss at 50°. After 20 days, avocados stored in CA at both 45° and 50° lost less weight than fruit stored in air at either temperature although this difference was not significant at 45°. In contrast, the total percentage weight loss of fruit after softening was greater in fruit which had been stored in CA. The increased weight loss during softening of avocados previously stored in CA is related to the time required for the fruit to soften; fruit which softened more slowly were subject to physiological weight losses due to respiration and transpiration for longer periods of time. Analysis of the relationship between the number of days for fruit to soften at 70° and the percentage weight loss during softening was highly significant ($r=0.741$, 14d.f.).

LITERATURE CITED

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