Avocado Postharvest Biology: Determinants of Eating Quality

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Executive Summary
2009 - 2012

Introduction

This research project addresses the following research priorities as outlined in the 2009 CAC RFP:

1. Improving the quality of avocado fruit at retail and the identification of points in the handling and distribution chain where a loss of quality and profits may be occurring.
2. Define those fruit quality criteria or consumer perceptions of quality that may provide competitive advantage to California growers. Benchmark fruit quality against local harvest season timing, harvest conditions, imported fruit quality in the market in the same season, and/or environmental impacts of industry production practices on carbon and or pesticide footprints.

We built upon preliminary research conducted by White et al (unpublished, NZ), work we conducted in relation to reexamining the minimum maturity index for 'Hass' (Arpaia, 2003) and work carried out through funding by the Pinkerton Growers' Association (Obenland et al, 2012). In this preliminary work we: 1) reconfirmed the 1983 recommendation of Lee et al (1983) that the minimum dry weight standard for 'Hass' should be higher than the current standard based on sensory analysis and 2) that descriptor analysis showed that there was a clear relationship between certain textural and flavor characteristics and acceptability.

We conducted our research in three phases. These are outlined below.

Phase 1: Examined the relationship between acceptability and fruit maturity from early through late season

This research was carried out using a single grower source (Moorpark) throughout the harvest season. Harvesting commenced in January 2012 and the last of 8 harvests occurred in August 2010. Individual dry matter was taken on each fruit using a method developed by Arpaia and Hofshi (unpublished data) and linked back to eating acceptability. Additionally samples were taken to determine the most important fruit volatiles involved in eating acceptability. All fruit tasting was done using a volunteer panel from the staff at the UC Kearney Ag Center. We also examined the changes in the fruit's volatile profile and carbohydrate content during ripening using fruits from a mid-season harvest.

The outcomes of this research are the following:

a) The eating acceptability of the fruit is highly correlated to fruit texture (creaminess), richness of flavor and reduced "grassy" flavor. Fruit of low dry matter were rated as more watery in texture, bland in flavor and having more "grassy" flavor.
b) The volatiles responsible for the "grassy" flavor of early season fruit were identified as hexanal, 2,4 hexadienal and (E)-2-hexenal.
c) The volatile profile of the fruit changes across the harvest season. Certain volatiles were highly correlated with eating acceptability.
d) Fruit volatiles and fruit carbohydrates change dramatically during fruit ripening.
e) The results of this work were published in 2012 in the peer-reviewed journal, Postharvest Biology and Technology (reprint available upon request).

Phase 2: Examined the influence of ripening fruit to "near" ripe then storing the fruit at low temperature with the idea that acceptability may decline with prolonged holding of "near ripe" fruit

This research built upon the knowledge gained in Phase 1 and was carried out using a single grower source (Fillmore) throughout the harvest season. Fruit were sampled 5 times during the commercial season (March – August). We compared eating quality of the fruit after storage for varying times (7 days or 14 days at 41ºF) and then ripened using ethylene. We also pre-ripened fruit to "near ripe" (4-5 lbf) and stored this fruit for ~11 or ~18 days either at 41 or 34ºF (when the 7 days or 14 days stored fruit were ripe) and compared overall fruit quality as well as sensory attributes.

The main outcomes of this research are:

a) Few postharvest problems were encountered. Near ripe fruit stored at 34ºF from the lower maturity harvests exhibited signs of external peel damage consistent with low temperature storage (discrete patches as described in White et al., 2009) for both storage durations. Fruit stored at 34ºF also had slightly higher levels of stem end rot which were associated with the first 2 harvest dates as well as the final harvest date. The incidence of postharvest fruit decay is consistent to results previously observed.
b) Pre-ripened fruit were slightly less fully colored when completely ripe as compared to fruit stored and then ripened. This effect was greatest with pre-ripened fruit stored at 34ºF.
c) Fruit acceptability changed throughout the season in a similar pattern observed in Phase 1.
d) There were no perceived eating quality differences detected by the sensory panelists due to treatment. Fruit ripened to 4-5 lbf and stored at either 41 or 34ºF were judged to be of equal eating quality as compared to fruit ripened immediately following storage. Eating quality for all storage treatments was comparable to fruit ripened following harvest.
e) Similar to the sensory data, no significant differences were detected in the volatile profiles of the ripened fruit.
f) These data suggest that pre-ripened fruit (4-5 lbf) can successfully be stored at low temperature without loss of eating quality, assuming that the fruit are handled to minimize mechanical damage. Storage of pre-ripened fruit of more mature

fruit can be as low as 34ºF. Storage at 34ºF for low maturity fruit (<24% dry matter) may result in peel damage which would detract from the fruit's visual appearance.

Phase 3: Examined the role of ripening temperature on acceptability.

This research built upon the knowledge gained in Phases 1 and 2. It was carried out using a single grower source (Fillmore) throughout the harvest season. Fruit were sampled 7 times during the commercial season (January – September). Fruit were ripened with ethylene after either 4 or 14 days storage at 41ºF at 5 temperatures: 59, 64.4, 68, 73.4 or 77ºF. Fruit from 59, 68 and 77ºF were presented to volunteer panelists for sensory evaluation and samples from these same fruit were analyzed for volatile composition.

This research concludes:

a) The Phase 3 research corroborated our previous work demonstrating that eating acceptability changes throughout the harvest season.
b) Low dry matter fruit (<24% dry matter) tend to be rated as watery and grassy in flavor whereas late season fruit tend to be rated as drier in texture but richer and less grassy in flavor.
c) There was no significant effect of ripening temperature on volatile composition.
d) Ripening temperature does not greatly influence ripe fruit quality with the exception of texture where fruit ripened at the lowest temperature were perceived to be slightly less creamy.
e) Ripening temperature influences the time for ripening. Fruit ripened at lower temperatures tended to take longer to ripen and are subsequently more prone to postharvest decay when ripe. These fruit tended to be slightly less dark when ripe throughout the harvest season.

INDUSTRY RECOMMENDATIONS

Eating quality will change dramatically over the harvest season. Less acceptable fruit are generally characterized by watery texture and bland but "grassy" flavor. Fruit acceptability increases when average dry matter exceeds approximately 24% dry matter.

Fruit that are pre-ripened (4-5 lbf) can be successfully stored at low temperature for at least 7 days. Low maturity fruit will develop external peel damage symptoms when stored at 34ºF which is likely to impact subsequent marketing.

Ripening temperature (59 – 77ºF) after 4 or 14 days storage at 41ºF influences the days to final ripening and the ripe fruit color; fruit ripened at 59 or 63ºF took longer to ripen and were slightly less dark when ripe. There was a slight tendency for fruit ripened at 59ºF to be perceived as less creamy in texture in late-season fruit.

Cited Literature

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