Avocado Postharvest Biology: Determinants of Eating Quality

Mary Lu Arpaia (UC Riverside)
David Obenland (USDA-ARS)

Technical Support Staff: J. Sievert, S. Collin and P. Neipp

This study was funded at a lower level than initially requested. In spite of the budgetary shortfall we have made good progress on the objectives laid out for Year 1 of the project.

This study aims to build on the detailed sensory analysis of NZ grown avocado flavor by a trained panel (Woolf et al, personal communication) and to define sensory attributes of 'Hass' avocado fruit grown in California. We have also initiated a parallel study to characterize the volatiles of 'Hass' avocado during the same time period. Results will aid our understanding of minimum and maximum maturity levels in Californian grown 'Hass' avocado fruit. This methodology could later be extended to an examination of postharvest handling practices on eating quality as well as being incorporated into the avocado variety improvement program (as we identify potential genetic markers for these traits in collaboration with Drs. Clegg and Smith).

We had 3 objectives for Year 1 of this project:

1) Refine a list of flavor descriptors using the list originally developed in New Zealand by the Plant and Food Institute at the Mt. Albert Research Center and modified during preliminary work in 2009;
2) Develop a methodology for quantifying aroma active compounds in ripe 'Hass' avocado;
3) Follow the changes over the season in descriptor data, hedonic ranking and aroma active compounds over the course of the California 'Hass' maturity season.

Progress to date.

The results presented here are preliminary from the perspective that one of the goals of this year's efforts was to fine tune some of our experimental methodologies.

We identified a grower cooperator near Moorpark, CA in Ventura CA from which to procure fruit at approximately 4-6 week intervals. The fruit used for this study are from approximately 15 year 'Hass' avocado planted at the base of a north facing slope. We selected this site since we wanted to insure that we could sample low maturity fruit at the beginning of the study and carry forward through the complete harvest season. We harvested fruit 8 times. The fruit were harvested in the morning and then taken to the UC Kearney Agricultural Center (UCKAC); about 3.5 hours. The fruit were held overnight at 41F (90% RH); the following morning dry weight was determined on an individual fruit basis using the coring method, where two equal tissue plugs are removed from the fruit equator, and dried to constant weight using a dehydrator. Drying normally took approximately 48 hours. An acrylic rod equal to the diameter of the fruit plug removed is placed in the fruit opening. In this way, we are able to store and ripen the fruit with minimal effect. This methodology is the same method used in the previously funded 'Hass' and 'Lamb Hass' maturity projects. The fruit were stored for 1 week at 41F to simulate commercial holding then ripened at 68F (90% RH) using 40 to 60 ppm ethylene for 48 to 72 hours. Once sufficient numbers of fruit were ripe samples were presented to volunteer panelists from the staff at UCKAC.

All sensory testing was done in the UCKAC Sensory Facility. Fruit were tracked on an individual basis usually with 7 – 8 panelists tasting each fruit. Panelists were presented 9 samples. Samples were taken from the equator portion of the fruit. Samples were served in a white 1.5-ounce paper soufflé cup. Each cup was identified with a unique 3-digit random number and was served on a small tray with white background. Samples were presented in random order so that each panelist received the set of samples in a different order so as to minimize order effects. Panelists were instructed to rate the samples in the order presented. They were also instructed to rinse their mouth with the distilled water prior to beginning and between each sample to minimize carry-over effects between samples and to take a small bite of carrot before rinsing their mouths with water. The carrots serve as a palette cleanser between samples. We switched to carrots from non-salted crackers following discussions with H. Heymann, Professor of Viticulture and Enology at UC Davis and an expert in consumer testing.

Panelists gave a hedonic score for each sample ranging from 1 to 9, with 1 being dislike extremely and 9 being like extremely. Ratings were also given for creaminess, grassiness and richness present by marking lines on 150-mm line scales. The measured distance from the 0-point indicated the intensity of the sensory attribute, with a greater number indicating more creaminess and richness but less grassiness. Richness is a measure of the degree of avocado-like flavor that is present. These descriptors were used following a review of the descriptor data we collected in preliminary work during 2009.

At the time of testing, fruit samples were also taken for determination of the presence of aroma active compounds. The measurement of aroma active compounds was conducted the USDA/ARS San Joaquin Agricultural Sciences Center which is less than ½ mile from the UCKAC.

Sensory Panel Results. Figure 1 presents the findings for the sensory component of the project. Figure 1A shows the changes in average dry matter across all harvests. Note that the average dry matter for the first two harvests was actually below that of the legal minimum maturity. The average for the third harvest was 22.6%. Figure 1B presents the results for the rating of individual fruit with known dry matter. The fruit were not rated in the “like slightly” category (score of 6) until the dry matter exceeded 22%. Likewise the texture and flavor intensity ratings increased substantially when dry matter exceed 22%. The panelists rated higher dry matter fruit as less “grassy”, and there was a general trend through the harvest season for increasing scores.

Aroma Active Compounds (AAC). We sampled fruit from each harvest which represented the range of dry matter present in the fruit. We also conducted an additional test to examine the AAC present in unripe and ripe fruit. We have found several AAC when running the samples. There are 5 aldehyde compounds that have changed dramatically over the course of this study and which appear to be related to the changes in sensory perception of the term “Grassy”. We are in the process of finalizing the results of this portion of the project.

We also conducted a ripening curve in April to assess whether the AAC change during fruit ripening, and if so at what stage of ripening this change occurs. We conducted a ripening curve by measuring fruit respiration and ethylene production, fruit firmness (using a penetrometer) and then extracting the AAC. We also collected subsamples of the individual fruit for subsequent sugar and fatty acid analysis. We are also in the process of finalizing this portion of the project.

Changes in dry matter during ripening. We have been asked several times from industry representatives as well as members of the retail and wholesale trade if dry matter changes during fruit ripening. We conducted preliminary work on this subject in 2001 but focused on high dry matter fruit. This year any fruit that was not used for sensory analysis was used to determine the ripe dry matter. Since we know each fruit’s harvest dry weight we were able to examine if fruit ripening had an impact on dry matter content. Figure 2 presents the results of the combined 2002 and 2010 study. As expected, there is a close correlation between the unripe and ripe dry matter content. However, we noted that dry matter typically decreases during fruit ripening by approximately 1.7%. That is, if a fruit was 22% in an unripe state, its ripe dry matter would be 20.3% when ripe. There was no significant difference between the ripe/unripe dry matter due to fruit maturity. We will continue to collect additional data in subsequent years of this project to better understand this relationship.

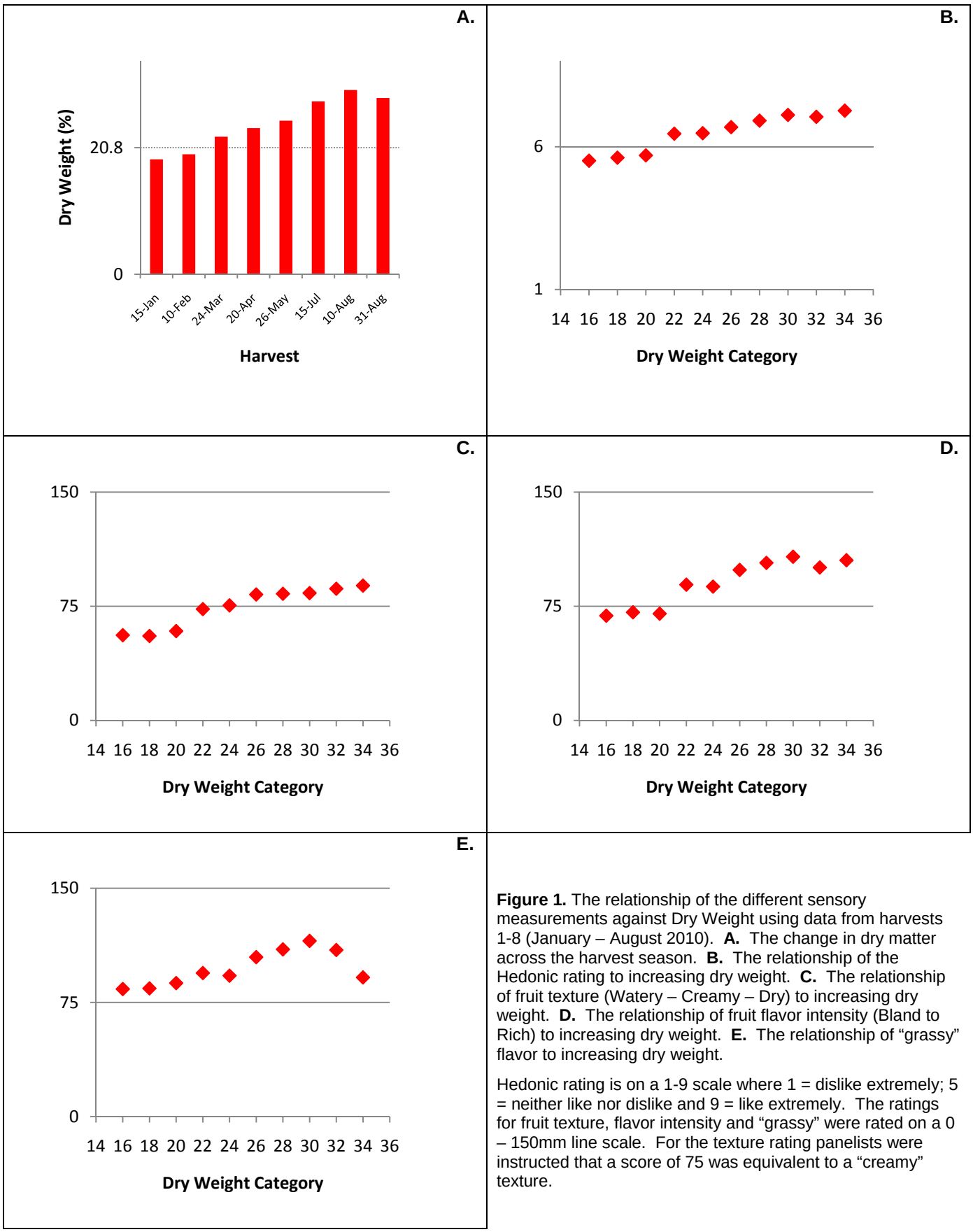

Figure 1. The relationship of the different sensory measurements against Dry Weight using data from harvests 1-8 (January – August 2010). **A.** The change in dry matter across the harvest season. **B.** The relationship of the Hedonic rating to increasing dry weight. **C.** The relationship of fruit texture (Watery – Creamy – Dry) to increasing dry weight. **D.** The relationship of fruit flavor intensity (Bland to Rich) to increasing dry weight. **E.** The relationship of "grassy" flavor to increasing dry weight.

Hedonic rating is on a 1-9 scale where 1 = dislike extremely; 5 = neither like nor dislike and 9 = like extremely. The ratings for fruit texture, flavor intensity and "grassy" were rated on a 0 – 150mm line scale. For the texture rating panelists were instructed that a score of 75 was equivalent to a "creamy" texture.

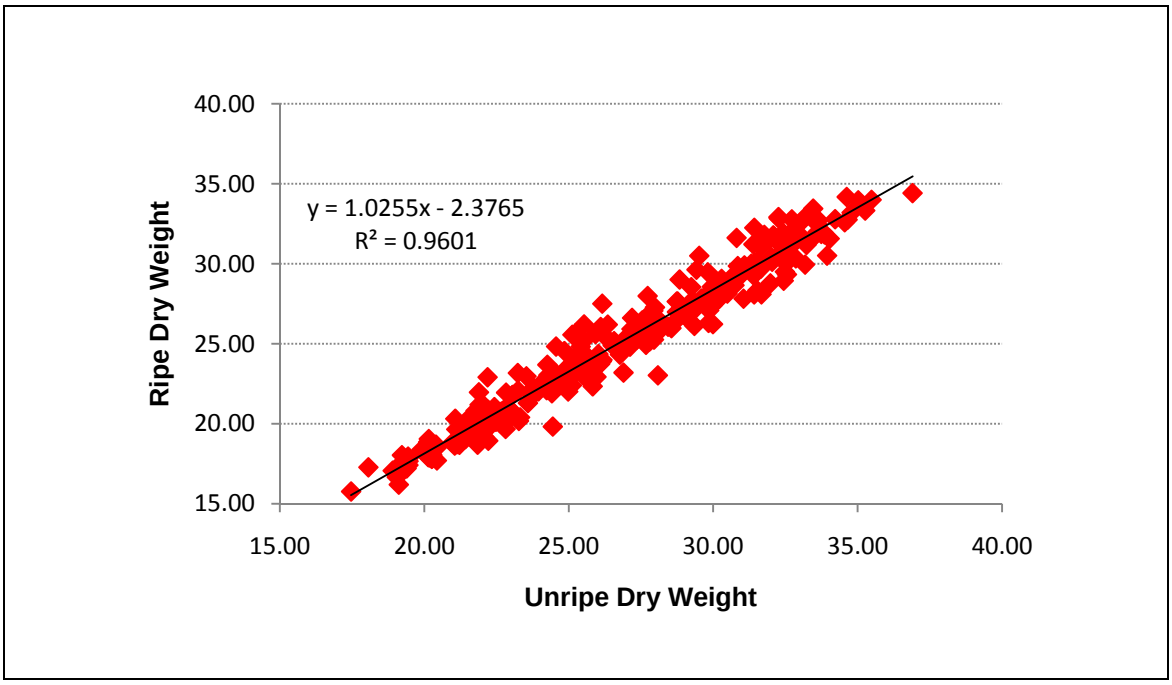

Figure 2. The relationship between the unripe dry weight and ripe dry weight (N=297 fruit).