

# REFLECTANCE SPECTROSCOPY TO DETERMINE DRY MATTER CONTENT IN 'HASS' AVOCADO FRUIT

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## INTRODUCTION

Avocado fruit maturity is usually assessed by measuring its pulp dry matter (DM) content, a destructive and time-consuming process that could only be performed on harvested fruit. An alternate non-destructive method that could be used in situ to determine avocado DM content would therefore be beneficial to producers and other stakeholders. The objective of this investigation was to assess the potential of reflectance spectroscopy to determine DM content in 'Hass' avocado fruit.

## MATERIALS AND METHODS

Two experiments were conducted. In the first one, fruit from three avocado lots from the same orchard in the state of Nayarit (Mexico) were analyzed weekly. Individual intact fruit were used for spectra data acquisition by two methods: a) without removing the fruit between spectra acquisition, and b) removing the fruit. Ten spectra readings were obtained for each fruit in the dorsal or ventral position in the top, middle and bottom part using an Ocean Optics USB 4000 spectrometer in the 345 - 1047 nm spectral region. DM content of each fruit was also determined using the microwave method. Spectra and DM were correlated. In the second experiment, 10 trees were selected from an orchard located in Tepic county, Nayarit. Thirty fruit per tree were tagged when they were 2-3 cm in length. Harvests were performed from 5 July to 15 September, 2011. At harvest, 20 fruit were analyzed with the same spectrometer as in the first experiment. Five readings were taken in the dorsal-middle part of each fruit. Also, DM content was determined and data were correlated.

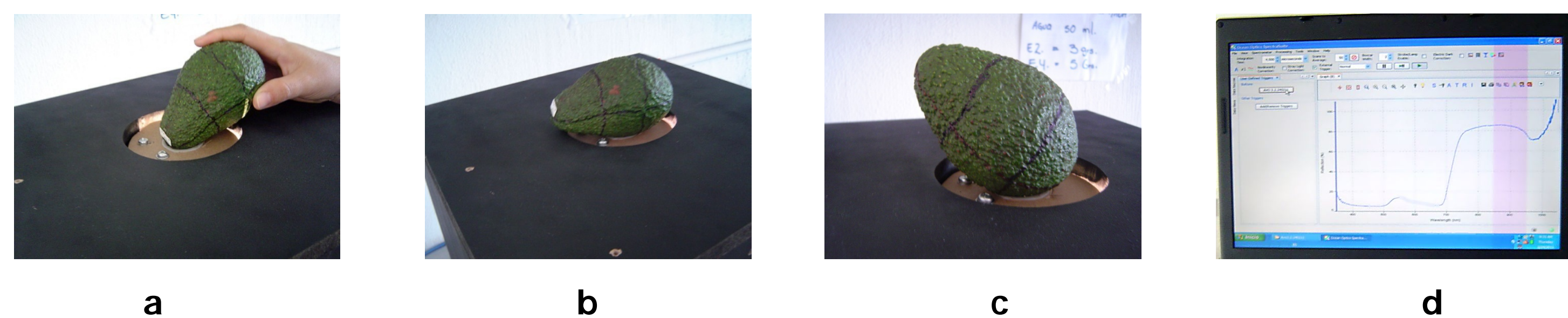


Figure 1. Position of avocado fruit: Top (a), Middle (b), Bottom (c). Resultant spectra (d).

## RESULTS AND DISCUSSION

The first experiment indicated that fruit positioning on the spectrometer introduces some variation to the measurement. Significant differences were detected for acquisition of the spectra without removing or removing the fruit. Spectra acquired without removing the fruit showed coefficient of variations less than 3 % while spectra acquired removing the fruit showed coefficient of variations higher than 7 % (Table 1). In addition, significant differences were detected for DM content among harvest dates, sides and positions of fruit. Consequently, a significant ( $P < 0.0001$ ) but weak negative correlation ( $R^2 = -0.469$ ) was detected between reflectance and DM content (Tables 2, 3, 4 and 5).

Table 1. Distribution of the coefficient of variation from 10 successive spectra readings according to the method used.

POSITION	REMOVING FRUIT			WITHOUT REMOVING		
	<3 %	4-6%	>7%	<3%	4-6%	>7%
DORSAL TOP	73.3	23.3	3.3	100.0	0.0	0.0
VENTRAL TOP	66.7	26.7	6.7	100.0	0.0	0.0
DORSAL MIDDLE	60.0	33.3	6.7	100.0	0.0	0.0
VENTRAL MIDDLE	43.3	56.7	0.0	100.0	0.0	0.0
DORSAL BOTTOM	56.7	33.3	10.0	100.0	0.0	0.0
VENTRAL BOTTOM	66.7	20.0	20.0	100.0	0.0	0.0

Table 2. Effect of harvest date on reflectance and dry matter content of 'Hass' avocado fruit. May, 2011.

HARVEST DATE	REFLECTANCE (%)	DM (%)
FEBRUARY 22, 2011	81.5 a	28.1 b
FEBRUARY 28, 2011	79.8 ab	28.7 b
MARCH 07, 2011	77.9 b	31.6 a

Means with different letter in columns are statistically different (Duncan  $P \leq 0.05$ )

Table 3. Effect of side on reflectance and dry matter content of 'Hass' avocado fruit. May, 2011.

SIDE	REFLECTANCE (%)	DM (%)
DORSAL	82.1 a	28.7 b
VENTRAL	77.4 b	30.2 a

Means with different letter in columns are statistically different (Duncan  $P \leq 0.05$ )

Table 4. Effect of position on reflectance and dry matter content of 'Hass' avocado fruit. May, 2011.

POSICIÓN	REFLECTANCE (%)	DM (%)
TOP	77.3 b	28.1 b
MIDDLE	82.7 a	28.7 b
BOTTOM	79.3 b	31.6 a

Means with different letter in columns are statistically different (Duncan  $P \leq 0.05$ )

Table 5. Relationship between reflectance and dry matter content. May, 2011.

	REFLECTANCE
DM	- 0.469
P	< 0.0001

For the second experiment, reflectance at 820 nm was weakly correlated with DM. Results suggest that it was not possible to predict avocado maturity using reflectance spectroscopy in the spectral window used in these experiments.

Table 5. Effect of harvest date on percent of dry matter and reflectance of 'Hass' avocado fruit. September, 2011.

HARVEST	DATE	DM (%)	REFLECTANCE AT 820 nm	
			AT HARVEST	AT FULL RIPENESS
1	JULY 5, 2011	15.9 c	83.6	71.1
2	JULY 28, 2011	18.0 b	83.2	76.6
3	AUGUST 11, 2011	19.1 b	84.6	74.9
4	AUGUST 26, 2011	19.4 b	80.2	-
5	SEPTEMBER 15, 2011	23.5 a	84.2	69.3

## CONCLUSIONS

- Positioning the probe on the fruit introduces variation in the spectra.
- Significant differences were detected for acquisition of the fruit spectra between methods, being better the one without removing the fruit.
- Significant differences were detected for reflectance and fruit dry matter content among harvest dates, side and position of fruit.
- A weak but significant negative correlation between dry matter and maximum reflectance at 820 nm was detected.
- For practical issues, it is suggested that spectra should be obtained from the dorsal middle part of the fruit.
- It was not possible to predict avocado maturity using reflectance spectroscopy in the spectral window used in this study.
- Reflectance spectroscopy measurements further in the near-infrared (1000-2500 nm) will be investigated to assess avocado fruit maturity.

## REFERENCES

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