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Determining Maturity in Whole Avocados

Bob Bergh, Junji Kumamoto
Botany and Plant Sciences, University of California, Riverside

Paul Chen
Agricultural Engineering, University of California, Davis

Introduction

Unlike many fruits, avocado maturity does not coincide with ripeness. An avocado becomes ripe—softens, and so can be eaten—only after it has been picked from the tree, requiring several days at room temperature. This delay adds to the problem of determining proper fruit maturity.

Avocados do change in appearance as they approach maturity. The skin loses some of its glossiness, becoming duller; surface russeting increases; varieties that turn black on ripening may become partly so on the tree. When cut open on picking, a mature fruit will slice smoothly, without a crackling sound or rough cut surface. Also, the seed coat will usually be thin and brown instead of fleshy and white.

The ultimate test is picking a fruit and letting it ripen. Mature avocado varieties vary widely in pleasantness of flavor, but an immature fruit of any variety will likely shrivel as it ripens and have a watery, bland, or even "grassy" flavor.

However, visual observation and personal taste testing is too subjective when legal standards are necessary to keep immature fruit off the commercial market. For decades, the accepted objective measure of lawful maturity was fruit oil percentage. The rather arbitrary legal oil minimum for all varieties in California was 8%. (Somewhat higher levels ensure better eating quality in many varieties). The procedure for determining oil percentage is expensive and laborious and prone to error (Lee, 1982).

A significant improvement was the replacing of direct oil percentage with determination of dry matter. Because the sum of fruit oil plus water commonly remains nearly constant as fruit develops, one need only determine the water content, such as by drying a fruit slice in a microwave oven, to obtain the oil percentage by subtraction. Thus, any grower can now determine the relative oil level of his own fruit (Lee, 1982; Lee *et al.*, 1983). The final step in commercial application is to correlate calculated values with eating quality for each important variety.

NMR Method

NMR, nuclear magnetic resonance, has been used for some time to measure the quantity of liquid oil in a substance, such as by a Newport Analyser Mark III (Lee, 1982). It does this by passing radio-frequency energy through the substance, thereby exciting hydrogen atoms which emit radio-frequency signals that are measurable by a spectroscope to give an oil content reading. A problem has been that the substance must be completely dry, since otherwise the hydrogen atoms in water will confound the oil measurement (Lee, 1982).

Recent advances in chemical-physical research have produced NMR spectrometer procedures for a number of specialized applications. For example, they are now being used to image internal human structures for medical diagnoses. And now, because the signals from oil and water hydrogen atoms decay at different rates, it is possible to obtain oil-enhanced images of undried avocado slices (Fig. 1). Note how the image becomes brighter with advancing maturity.

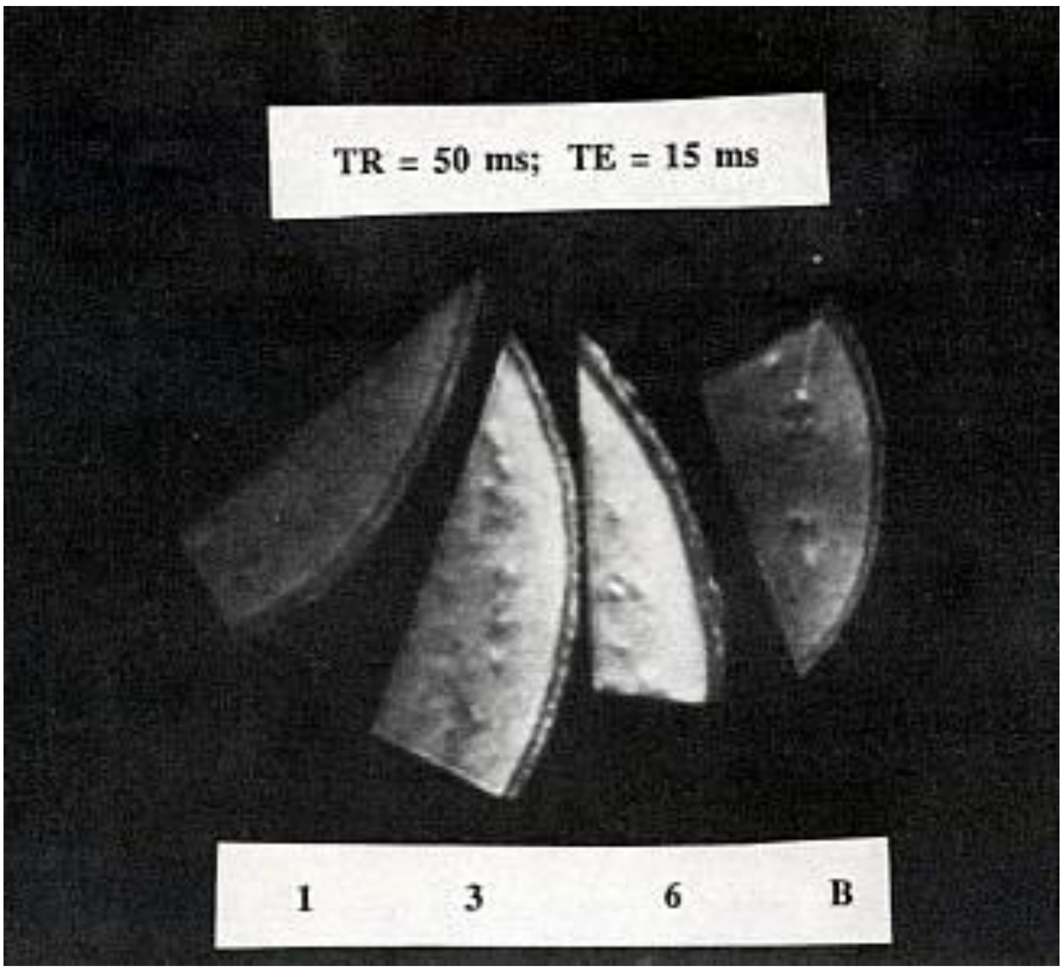

Figure 1. NMR imaging of fresh avocado slices from four fruits. Slices 1(1) and 4 (B) were from immature fruits, 2 (3) was nearly mature, and number 3 (6) was mature: the image brightens with maturity.

The procedure is extremely complex. It involves the theory of nuclear-magnetic spin systems under the influence of magnetic fields and pulses of radio-frequency energy, with the resulting rates of signal decay yielding measurements by means of unimolecular kinetics.

NMR Oil Analysis of Entire Fruit

The new method is now being used to evaluate the internal quality of various types of intact fruits (Chen *et al.,* 1989). Toward the ultimate goal of determining maturity in intact avocados, preliminary signal scans have been run (Fig. 2). This illustrates that the method is clearly sensitive enough to show differences in oil percentages between different parts of the same fruit.

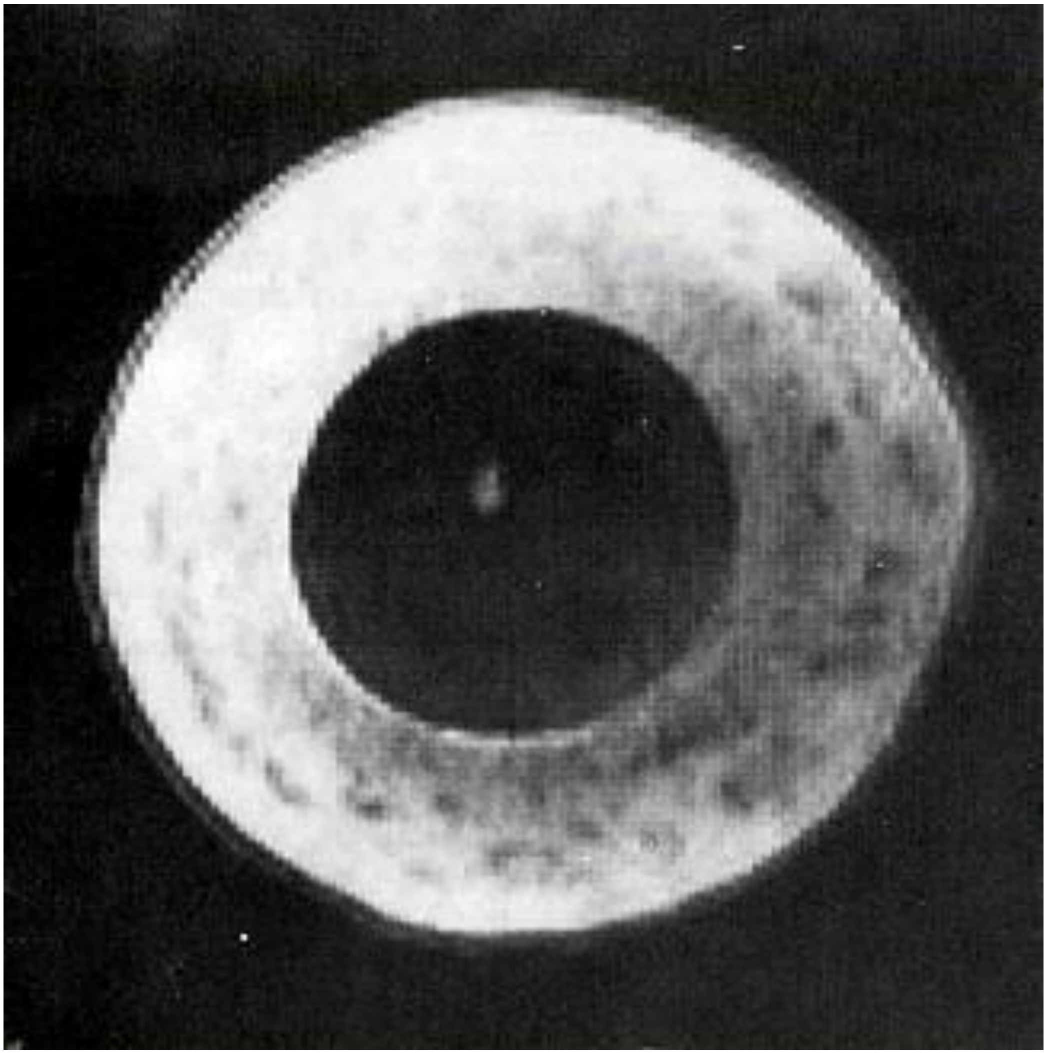

Figure 2. NMR imaging of an intact avocado. The fruit was then cut open and analyzed: the upper left region had 2.1% more dry matter than the lower right region.

These new techniques have the major advantages of simplicity of operation, speed of determination, and accuracy of measurement. The chief disadvantage is high equipment cost, but efforts are being made to develop new low-cost equipment for agricultural applications.

References

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