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An Analytical Assay for the Determination of Oil Content in Avocado

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Introduction

The quality and taste of avocado depend on the variety and on the degree of the fruit maturity before harvesting. Since the size, shape, or color of the fruit can not serve as an index of physiological maturity, indirect indices are employed. The best results have been obtained with a taste panel, but this method has the disadvantage of the time elapsing between the fruit picking and tasting. Alternatively, chemical parameters of fruit components which provide a good correlation with physiological maturity and taste panel results have been suggested. One of the correlating factors is the oil content, which was shown to increase when the fruit matured. As a result of these studies, the Department of Agriculture in California set a minimum level of 8% fat after which harvesting is permitted. This recommendation was in effect until recently, despite the difficulties in performing the oil content test and alternative methods suggested {Lee, 1981).

Several methods for determining oil content in avocado have been reported:

1. Extraction with petroleum-ether in a Soxhlet apparatus and gravimetric determination of oil content (Horwitz, 1975);

2. Refractive index (HI) determination of an oil extract with chloronaphthalene (Halowax), (Shannon, 1949; Harkness, 1954);

3. Determination of oil by nuclear magnetic resonance (NMR) (Barry *et al.,* 1983);

4. Determination of the fruit dry matter, assuming a good correlation between this parameter and oil content (Hughes, 1971).

While Soxhlet extraction is accurate, it is tediously long; the RI method, although accepted as an international standard, is of questionable accuracy (Stahl, 1933); and chloronaphthalene is suspected of being a health hazard; NMR determination requires expensive equipment; and determination of dry matter is still not acceptable by all growers.

In the dairy industry, there is great importance attached to the determination of fat in

dairy products. Fast and accurate methods were developed to carry out this test. Two, basically similar, methods are in use: the Gerber and the Babcock method (Atherton & Newlander, 1977). The Gerber method is the standard method in most European countries, while the Babcock one is in use in many states in the U.S.A., although the Gerber method is also practiced. Both methods are based on the digestion of all milk components, except oil, by concentrated sulfuric acid, and the separation of the oil from the aqueous phase by centrifugation in special glassware called butyrometers. In addition to fluid milk products, the Gerber test can be used for the assay of fat in cream, concentrated milk, ice cream, cheeses, and sausages (Pearson, 1970), provided that special both-ends-open butyrometers are employed. The very similar Babcock method, with various digesting reagents, has been applied satisfactorily to fish products (Horwitz, 1975).

We report the use of a modified Gerber test for the determination of oil in [4] avocado. The speed, simplicity, and low expense of operation of the Gerber method may lead to its emergence as an accurate and convenient test for this assay (Rosenthal *et al.,* 1985).

Materials and Methods

The butyrometers used were for condensed milk, graduated from 0 to 20% or 0 to 12% fat. A standard Gerber centrifuge with 12 positions provided with a heating element and a 30-minute timer, was used (K. Schneider & Co. Ltd., Zurich}. A thermostatically controlled water bath (55°±2°C) served for holding the butyrometers until digestion was complete. For digestion, 70% sulfuric acid was used (m/m; D^{20}=1.615 g/ml).

Samples of unripe fruit were fine-grated, and these of ripe fruit were homogenized to a paste. A 2g sample was weighed into the glass beaker attached to the larger stopper and inserted into the butyrometer. The butyrometers were shaken gently to loosen the sample in order to avoid lumps, then 12 ml of acid was added through the narrow opening, and the butyrometers were immersed vertically in the water bath for 30 minutes, or until complete digestion of the pulp. The butyrometers were shaken every 10-15 minutes to accelerate digestion. When the liquid mass appeared homogeneous, the butyrometers were filled with acid up to two-thirds of the neck height and plugged with the small stopper. The butyrometers were placed in the heated centrifuge and spun for 15-20 minutes, and then in the heated water bath for 3-5 minutes. The height of the oil column was read off the graduated neck and the reading obtained at the bottom was subtracted from that obtained at the top of the oil column (lower meniscus). The reading should preferably be done by moving the large stopper slightly in or out, to bring the bottom of the oil column — with a minimum of movement — to a graduation mark. The reading, multiplied by the calibration factor of 2.5, gives the oil content as expressed in grams of oil per 100 g of sample.

Results and Discussion

In order to obtain the optimal parameters for oil determination in avocado according to the proposed method, various acid concentrations and digestion temperatures were checked. It was found that not every combination of acid and digestion temperature suited this fruit. An acid concentration higher than 70% and digestion temperatures of 40-80°C resulted in complete burning of the sample, and it was impossible to separate the oil. On the other hand, acid concentrations of 40-65%, and very high temperatures (up to 90°C), did not digest all the pulp, and oil separation was incomplete. After running a large number of samples, the conditions described in the Materials and Methods section were reached. It should be noted that at the given conditions, a longer digestion time does not alter the final oil reading. The time stated was set as the minimum required for complete digestion. In very soft and mature samples, with high oil content, this period might have to be extended.

Over 30 samples were checked from different avocado varieties, including Fuerte, Monroe, Hass, and Ettinger, with oil levels of 5 to 22%. In parallel, the oil content of the same samples was determined by Soxhlet extraction and RI.

Statistical analysis of the regression correlation between the standard methods of Soxhlet and RI and the new method was performed and is summarized in Table 1. The results of the proposed new method correlate well at the 99% level with the two other tests, as can be seen from the r values obtained: Soxhlet *vs.* Gerber, r=0.928; RI *vs.* Gerber, r=0.893; Soxhlet *vs.* RI, r=0.903.

Table 1. Linear regression of oil determination according to the Soxhlet extraction, refractive index and Gerber methods.

	Linear equation[a] (Y = B+ax)	r[a] (calc)	S.D. of B	Mean Y	Mean x
Soxhlet *vs.* Gerber	Y = .57+.989 x	.928	.81	13.60[b]	13.17[b]
RI *vs.* Gerber	Y = 1.34+.873 x	.893	.87	12.57[c]	12.85[c]
Soxhlet *vs.* RI	Y = 1.65+.952 x	.903	.89	13.61[d]	12.57[d]

[a] r calculated at 99%

[b] Soxhlet = Y; Gerber = x

[c] RI = Y; Gerber = x

[d] Soxhlet = Y; RI = x

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