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Maturity Standards for Fuerte Fruit in the Kwazulu/Natal Midlands

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INTRODUCTION

Fruit maturity is a key issue for harvesting and post-harvest handling and avocado fruit are no exception. Physiologically, maturity may be defined as that stage of development at which the fruit, once detached from the tree, will ripen and result in a product desirable for eating (Young & Lee, 1989). Immature fruit are known to be bland and likely to shrivel as they ripen (Bergh *et al,* 1989), and in extreme cases the fruit may not even soften. Due to the misconception that avocado fruit are very hardy, they are not treated with as much respect post-harvest, as perhaps they should be and it is probably for this reason that less attention has been paid to over maturity of the fruit. Although some cultivars e.g. Hass may be left to hang on the tree for extended periods of time without subsequent deterioration of fruit quality (Kaiser & Wolstenholme, 1994), others may not be suited to delayed harvesting as fruit senescence while on the tree is probably a limiting factor. The fact that Fuerte avocado fruit are more prone to post-harvest physiological disorders than are Hass fruit (Witney *et al.,* 1990) is supporting evidence for this.

Consequently, it is imperative that maturity standards, both minimum and maximum be set for these fruit.

In the past, the only reliable maturity standard for avocado fruit was found to be total lipid content (Eaks & Sinclair, 1978) and this is still the case today (Kaiser, 1994). Since the total lipids and moisture content are reciprocal and sum to a constant for any one cultivar (Swarts, 1976) the moisture content is still used extensively by the South African industry as a maturity standard. For accuracy however, lipid levels should be determined on a dry mass basis, as the moisture content of the fruit will be determined by prevailing orchard conditions. On a different note however, Zauberman and Schiffmann-Nadel (1972) examined pectinmethylesterase activity (PME), the enzyme responsible for the initiation of the ripening process, in Fuerte fruit at various stages of development and ripening and found that PME activity on the day of harvest decreased with an increase in the stage of fruit development. In younger fruit, PME decreased rapidly while in mature fruit, PME decreased moderately and they suggested from these data that PME may be a possible maturity indicator. Apparently however, no further work has been done in this regard. Consequently, the present study was undertaken to determine whether PME is a suitable maturity marker for Fuerte fruit.

MATERIALS AND METHODS

On a weekly basis, 232 Fuerte fruit of count 16 (236g to 265g), from well managed orchards, were harvested over 8 weeks and handled normally on the farm Everdon Estate (Howick) from 17/05/94 until 6/07/94. Sixteen fruit were sampled on the day of harvest and fruit firmness, fruit and seed masses were recorded. The moisture content of the fruit flesh was determined gravimetrically and lipid percentages were determined using a soxhlet apparatus and plotted over time (Figure 1). In addition, pectinmethylesterase activity (PME) of radial sections was monitored by modification of the method developed by Hagerman and Austin (1986). Meanwhile, 80 fruit were placed in the laboratory and allowed to ripen at room temperature (21°C), and 8 fruit were sampled on each of the subsequent 10 days of storage.

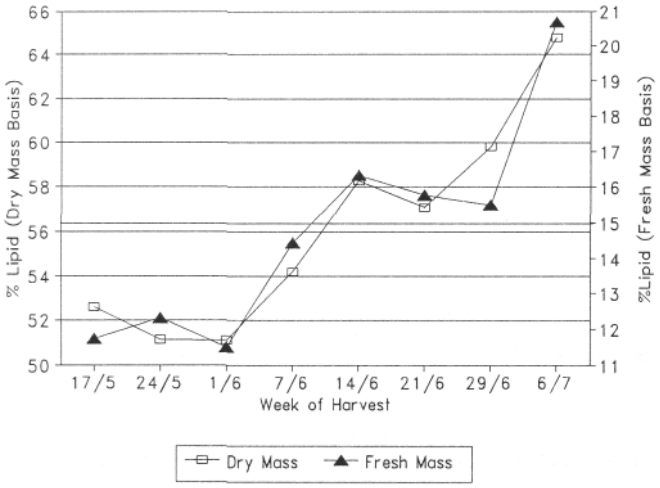

Figure 1
Average lipid content (%) on a dry and a fresh mass basis for Fuerte fruit harvested between 17/05/94 and 06/07/94 at Everdon Estate (Howick)

Fruit firmness, fruit and seed masses, and PME were also recorded for these fruit. The change in PME was analyzed statistically and plotted over time (Figure 2).

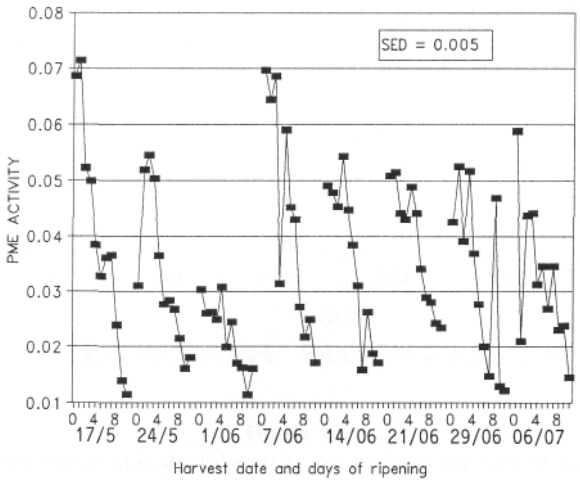

Figure 2
Average values of pectinmethylesterase activity (PME) for Fuerte fruit harvested at Everdon Estate (Howick) between 17/05/94 and 06/07/94 and allowed to ripen at room temperature (21°C)

Table 1
Storage temperatures (°C) for treatments 2, 4, 6 and 9 over 4 or 5 weeks of regular atmosphere storage.

Treat-ment	*Week 1*	*Week 2*	*Week 3*	*Week 4*	*Wee k 5*
2	8.5	8.5	7.5	6.5	
4	7.5	7.5	6.5	5.5	
6	5.5	5.5	5.5	5.5	
9	7.5	7.5	6.5	5.5	5.5

The remaining fruit were stored at four different temperature regimes. These storage regimes were identical to treatments 2, 4, 6 and 9 (See Table 1) of Donkin *et al.* (1995). During each week of storage, 8 fruit were removed from each treatment and firmness of the fruit recorded. These values were averaged for each week and the data plotted over time (Figures 3-6).

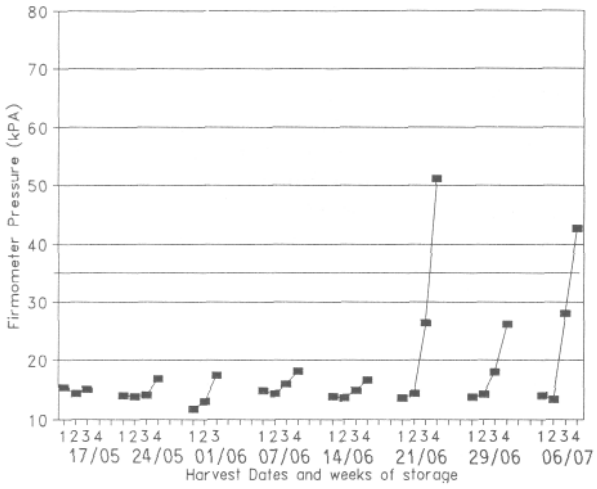

Figure 3
Firmometer readings (kPa) for fruit harvested weekly at Everdon Estate and kept in cold storage for 4 weeks at temperatures of 8.5°C, 8.5°C, 7.5°C, 6.5°C respectively (Treatment 2)

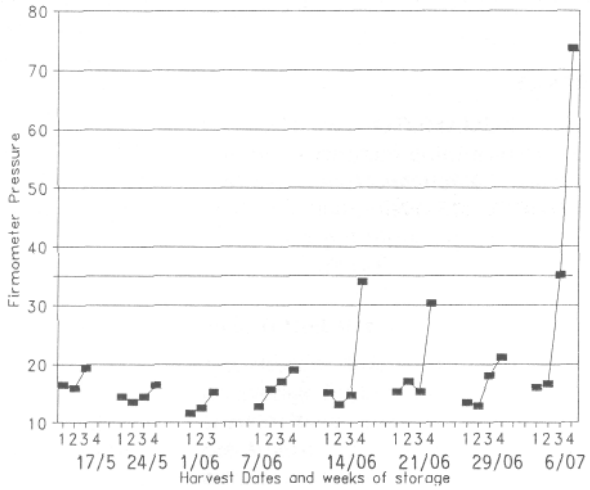

Figure 4
Firmometer readings (kPa) for fruit harvested weekly at Everdon Estate and kept in cold storage for 4 weeks at temperatures of 7.5°C, 7.5°C, 6.5°C, 5.5°C respectively (Treatment 4)

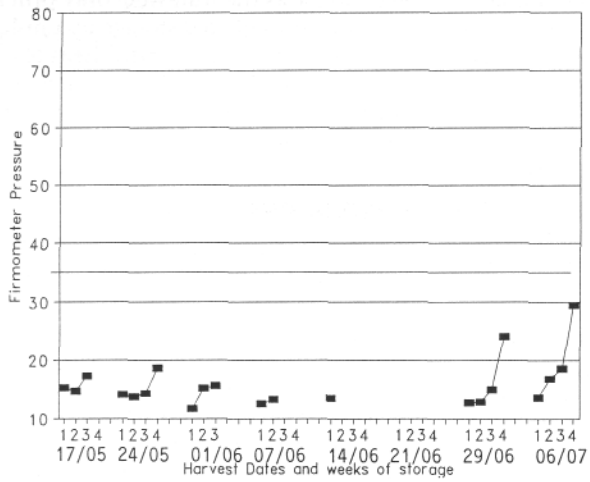

Figure 5
Firmometer readings (kPa) for fruit harvested weekly at Everdon Estate and kept in cold storage for 4 weeks at temperatures of 5.5°C, 5.5°C, 5.5°C, 5.5°C respectively (Treatment 6)

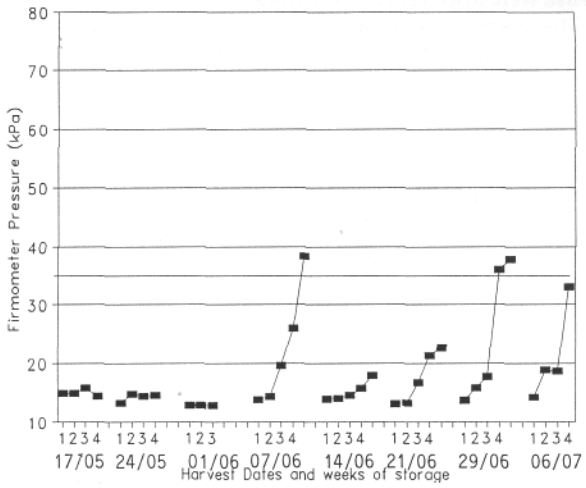

Figure 6
Firmometer readings (kPa) for fruit harvested weekly at Everdon Estate and kept in cold storage for 4 weeks at temperatures of 7.5°C, 7.5°C, 6.5°C, 5.5°C, 5.5°C respectively (Treatment 9)

RESULTS AND DISCUSSION

Lipid percentages increased over the season from about 11% on a fresh mass basis (or 53% on a dry mass basis) on 17/05/94 to slightly more than 20% on a fresh mass basis (or about 65% on a dry mass basis) on 6/07/94 with some minor fluctuations between these times (Figure 1).

PME activity usually increased the day after harvest but then declined steadily while the

fruit was ripening. With the exception of the 6th week of harvest (21/06/94), all the fruit were eating soft when the PME activity was less than 0.01 units. No definite trends in initial activity nor the rate of change of activity could be observed across the whole season however, two definite decreases in initial activity were observed between 17/05/94 and 01/06/94 in the first instance and 07/06/94 and 06/07/94 in the second instance (Figure 2). Whether or not these trends will be repeated will have to be determined in the 1995 season.

Of the four temperature trials, treatment 6 (5.5°C, 5.5°C, 5.5°C, 5.5°C) the industry norm, proved the best towards the latter part of the season, where fruit softness was concerned. Although some data was lost due to a malfunction in refrigeration equipment on one occasion, where temperatures rose to about 40°C, all the fruit kept at these temperatures were firm (less than 35kPa) after four weeks of storage. It should however, be noted that after 21/06/94 fruit in treatment 6 were beginning to soften after four weeks of storage but still had an acceptable firmness (Figure 5). Indeed, some of the fruit harvested in Kwazulu/Natal left Durban harbour on Vessel 906 on 25/06/94, and arrived in Europe soft (Hardy, 1995). It appears that the optimum harvesting date for Fuerte fruit in the Kwazulu/Natal midlands was up to 21/06/94. This corresponded to a lipid percentage of about 57% on a dry mass basis (or 15% on a fresh mass basis).

Fruit from treatment 2 (8.5°C, 8.5°C, 7.5°C, 6.5°C) were firm after four weeks of cold storage up until 21/06/94 (Figure 3) while those which underwent treatment 4 (7.5°C, 7.5°C, 6.5°C, 5.5°C) were only firm after four weeks of cold storage until 14/06/94 (Figure. 4). Treatment 9 (7.5°C, 7.5°C, 6.5°C, 5.5°C, 5.5°C) fared even worse as the fruit were only firm after four weeks of cold storage up until 7/06/94. Consequently, treatment 6 (5.5°C, 5.5°C, 5.5°C, 5.5°C) resulted in the firmest fruit after four weeks of cold storage (Figure. 6).

CONCLUSIONS

Fuerte fruit harvested in the Kwazulu/Natal midlands during the 1994 season stored best in regular atmospheric cold storage at a constant 5.5°C over 4 weeks during the latter part of the season, when compared to other stepped-up or stepped-down temperature regimes where fruit softness was concerned. The experimental fruit stored at this regime in South Africa were still relatively firm even when harvested after 21/06/94 however, some of the commercial consignments of fruit (on Vessels 906 and 907), which underwent similar storage conditions arriving in Europe 4 weeks after that date were soft. For the first three weeks (17/05/94 until 01/06/94) of storage however, there were no marked differences in fruit firmness where treatments 2, 4, 6 and 9 were concerned. Consequently, other parameters such as the incidence of cold damage and physiological disorders will determine the optimum storage temperature early in the season and it is imperative that temperature trials continue with this in mind. Lipid content, still the most reliable maturity standard for avocados to date, plateaued on 21/06/94 at approximately 58% on a dry mass basis (or 16% on a fresh mass basis). After that time it declined to about 57% on a dry mass basis (or 15% on a fresh mass basis) by 29/06/94. This, together with the fact that physiological browning disorders of the mesocarp (Donkin *et al.,* 1995) and distal-end browning (Kaiser, 1994) increased

after 21/06/94, indicates a maximum fruit maturity date.

A figure of 57% lipids on a dry mass basis (or 15% on fresh mass basis) is thus proposed for maximum maturity for Fuerte fruit in the Kwazulu/Natal midlands. However, it must be stressed that this figure must be validated over at least one more harvest season before recommendations may be made to growers. Analysis of PME activity showed two definite decreases in initial activity between 17/05/94 and 01/06/94 in the first instance and 07/06/94 and 06/07/94 in the second instance (Figure 2). Whether or not these trends will be repeated will have to be determined in the 1995 season. Finally, studies on cellulase activity as a potential maturity marker are under way and will be reported on in 1996.

REFERENCE

BERGH, B., KUMAMOTO, J. & CHEN, P. 1989. Determining maturity in whole avocados. *Californian Avocado Society Yearbook* 73: 173 - 176.

DONKIN, D.J., MANS, C.C., SLABBERT, M.J., LEVIN, J. & WOLSTENHOLME, B.N. 1995. "Stepped-down" storage temperature regimes for Fuerte fruit grown in the KwaZulu/Natal midlands: do they reduce the incidence of physiological disorders? *South African Avocado Growers' Association Yearbook* 18: 89 - 93.

EAKS, I. & SINCLAIR, W.B. 1978. Pectin and related constituents in avocado fruit ontogeny, cold storage and ripening. *Journal of the American Society for Horticultural Sciences* 103: 846 - 849.

HAGERMAN, A.E. & AUSTIN, P.J. 1986. Continuous spectrophotometric assay for plant pectin methyl esterase. *Journal of Agriculture and Food Chemistry* 34: 440 - 444.

HARDY, J. 1995. South African Avocado Growers' Association, Tzaneen.

KAISER, C. 1994. Evaluation of maturity standards in avocado fruit. *Subtrópico* 15: 18 - 20.

KAISER, C. 1995. Distal-end browning ('Bolverkleuring') of Fuerte fruit in the Kwazulu/Natal midlands. *South African Avocado Growers' Association Yearbook* 18: 99 - 101.

KAISER, C. & WOLSTENHOLME, B.N. 1994. Aspects of delayed harvest of Hass avocado *(Persea Americana* Mill.) fruit in a cool subtropical climate I. Fruit lipid and fatty acid accumulation. *Journal of Horticultural Science* 69*:* 437 - 445.

SWARTS, D.H., 1978. The no-nonsense determination of oil content for avocados. *Citrus and Subtropical Research Institute Information Bulletin* 42:4.

WITNEY, G.W., HOFMAN, P.J. & WOLSTENHOLME, B.N. 1990. Effect of cultivar, tree vigour and fruit position on calcium accumulation in avocado fruits. *Scientia Horticulturae* 44: 269 - 278.

YOUNG, R.E & LEE, S.K. 1978. Avocado fruit maturity. *Californian Avocado Society Yearbook* 62: 51 - 57.

ZAUBERMAN, G. & SCHIFFMANNNADEL, M. 1972. Pectin methylesterase and polygalacturonase in avocado fruit at various stages of development. *Plant Physiology* 49: 864 - 865.