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FRUIT MINERAL CONCENTRATIONS AND POSTHARVEST QUALITY OF 'HASS' AVOCADOS.

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Abstract

New Zealand avocado orchards (cv Hass) were surveyed to determine if an imbalance in fruit mineral concentrations (Ca, Mg, and K) was affecting fruit quality. Only one orchard had fruit with low Ca concentrations compared with overseas standards. These fruit had more vascular browning and flesh browning than fruit with high Ca concentrations. Also, fruit Ca concentrations were lower and the incidence of vascular browning higher in fruit that were more mature at harvest.

Introduction

Several preharvest factors will affect the postharvest quality of avocado fruit (Hofman and Smith, 1994). Important among these are fruit mineral concentrations, especially the levels of Ca, Mg and K. 'Fuerte' fruit with low Ca concentrations are more susceptible to the physiological disorders vascular browning and flesh browning (Chaplin and Scott, 1980; Bower and Cutting, 1988). Both of these disorders can be accentuated by cold storage. A similar relationship has been suggested for 'Hass' fruit, but has yet to be demonstrated (Cutting and Bower, 1992).

Our objective was to establish benchmark levels for Ca, Mg and K in New Zealand- grown 'Hass' avocados, and to examine the relationship between these fruit minerals and postharvest fruit quality.

Materials and Methods

Fruit at similar maturities were harvested from 'Hass' trees on 11 orchards distributed over the northern half of New Zealand. On each orchard, two fruit were selected from each of 30 trees. Harvested fruit were weighed, packed at random into single layer trays, stored for 3 weeks at 6 ºC, then transferred to 20 ºC until ripe. When ripe, fruit were weighed, assessed for external rots, cut into quarters longitudinally, the skin peeled away and the flesh assessed for stem end and body rots, vascular browning and flesh browning using a severity rating scale from 0 (absent) to 2 (severe).

Fruit maturity and mineral concentrations were determined from flesh samples (approximately 5g per fruit). Each sample was weighed, freeze-dried and re-weighed to give % dry weight (%dw), and converted to %dw at harvest by correcting for weight loss during storage and ripening. The dried tissue was then ground, and a 0.2 g subsample digested at 120 ºC for 120 mins in 2 mls concentrated HNO_3 After cooling to 60 ºC, a total of 2 mls 30% H_2O_2 was added

in 0.5 ml aliquots, and the digestion continued for 60 mins at 60 ºC, followed by 90 mins at 120 ºC. Digested samples were made up to 25 ml with distilled water (0.2% La), and analyzed for Ca, Mg and K by atomic absorption (AA). Soil and leaf samples were also collected from each orchard in March (late-summer) and sent to a commercial laboratory for mineral analyses.

Results

At harvest, average fruit weights were between 199 and 254g, and fruit maturities were between 24 and 37%dw. Most fruit ripened within 7 days of being removed from cool storage. Fruit from Orchard 3 took the longest ($P<0.001$) to ripen and they had the lowest ($P<0.001$) dry weights at harvest (10.2 days and 24%dw, respectively).

Fruit from Orchards 1 and 7 had the lowest ($P<0.05$) Ca concentrations with 28mg/100g dw and 25mg/100g dw, respectively (table 1). Mean fruit Mg concentrations were between 91 and 113 mg/100g dw, and K concentrations were between 1126 and 1608 mg/100g dw. There was no correlation between fruit mineral concentrations and soil and leaf concentrations (unpublished data).

Only fruit from Orchard 7 had significant ($P<0.001$) levels of vascular browning and flesh browning (table 1). On this orchard, fruit with low Ca concentrations had more vascular browning than fruit with high Ca concentrations (figure 1). Also, fruit Ca concentrations were lower in fruit which were more mature (higher %dw) at harvest ($r = -0.69$; $P<0.05$). Fruit Mg and K concentrations were not related to the incidence of physiological damage. The most common fruit rots observed were the anthracnose fungi *Colleototrichum gloeosporioides and C. acutatum,* and the soft rot fungus *Botryosphaeria parva* (Shelly Forbes, HortResearch). The percentage of fruit with severe rots ranged from 2% to 38% at Orchards 4 and 1, respectively (table 1). There was no correlation between fruit mineral concentrations and the incidence of fruit rots, but the percentage of fruit with severe rots increased with increasing fruit maturity at harvest ($r=0.72$, $P<0.001$).

Discussion

Only one New Zealand orchard had average fruit Ca concentrations less than those reported for South African fruit; 25 and 28 mg/100g dw, respectively (Cutting and Bower, 1992). On this orchard (Orchard 7), fruit with low Ca concentrations had more vascular browning and flesh browning than fruit with high Ca concentrations. This suggests that there is a threshold between 25 and 28 mg Ca /100g dw for, symptoms of Ca deficiency to appear, as fruit in New Zealand and South Africa with 28 mg Ca/100g dw had practically no vascular or flesh browning. Fruit Ca concentrations at Orchard 7 were lower and the incidence of vascular browning higher in fruit that were more mature at harvest. Cutting and Bower (1992) also reported decreasing Ca concentrations with increasing fruit maturity in 'Fuerte'. If fruit Ca concentrations are known to be low, then it would be important to harvest these fruit earlier than fruit from orchards with sufficient Ca.

It is not clear what caused the low levels of Ca in fruit from Orchard 7, as low fruit Ca did not correlate with low Ca concentrations in the leaves or soil. Avocado flowers have high transpiration rates and trees can suffer from excessive water loss during heavy flowering (Whiley *et al.*, 1988). This may have occurred at Orchard 7, and resulted in low Ca concentrations in fruit from this orchard (Bower and Cutting, 1988). Alternatively, water stress may have made these fruit more susceptible to physiological damage, independent of Ca concentration.

We did not find a direct link between fruit mineral concentrations and postharvest fruit rots. However, fruit that were more mature at harvest ripened more quickly than fruit that were less mature, and they were more susceptible to rot development, irrespective of fruit mineral concentration. We found no evidence that low Ca concentration caused fruit to ripen more quickly (Cutting and Bower, 1992).

In conclusion, Ca nutrition and harvest maturity are important determinates; of postharvest fruit quality in New Zealand-grown 'Hass' avocados. Harvesting fruit too early increases the risk of uneven ripening although there could be benefits from an extended ripening period. Harvesting fruit too late means that fruit are quick to ripen, but they are more susceptible to rots and physiological damage, especially if they have low Ca concentrations.

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Table 1 - Fruit mineral concentrations (mg/100g dw) and postharvest quality of 'Hass' avocados from 11 New Zealand orchards. Fruit quality data are % of fruit with severe symptoms. (Minerals data are accompanied by ± 1 s.e.)

Orchard	Calcium	Magnesium	Potassium	Fruit rots	Vascular browning	Flesh browning
1	28 ± 1.2	91 ± 1.5	1398 ± 11	38	2	0
2	42 ± 2.1	95 ± 1.7	1126 ± 21	12	2	0
3	37 ± 1.7	92 ± 1.2	1319 ± 27	20	2	0
4	42 ± 0.7	104 ± 0.8	1608 ± 22	2	0	0
5	41 ± 3.0	108 ± 0.3	1478 ± 20	13	2	0
6	37 ± 2.3	97 ± 2.2	1486 ± 18	18	0	0
7	25 ± 1.6	101 ± 0.9	1409 ± 29	13	23	12
8	47 ± 2.2	113 ± 3.3	1286 ± 23	22	7	0
9	42 ± 2.0	104 ± 1.7	1378 ± 41	22	8	0
10	37 ± 2.0	99 ± 1.9	1437 ± 19	15	2	0
11	42 ± 3.7	101 ± 0.6	1441 ± 51	32	2	0
ANOVA[1]				***	***	***

[1]Level of significance: ***=P<0.001

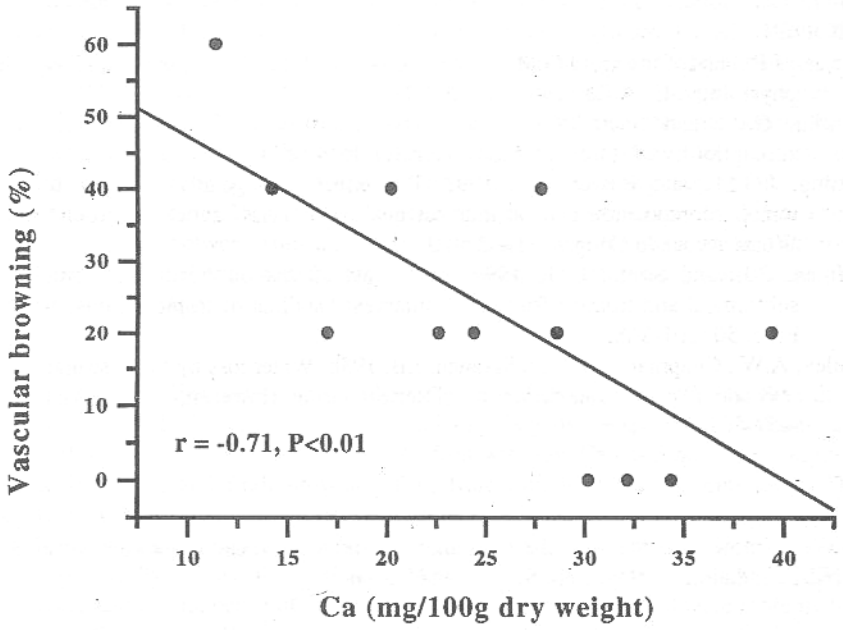

Figure1 - Fruit Ca concentration and the incidence of vascular browning (% of fruit with severe symptoms) in 'Hass' avocados. Fruit were stored for 3 weeks at 6°C, then ripened at 20°C. Each point is the mean of 5 fruit.