Firmness retention properties of ripened 'Maluma' avocado fruit

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ABSTRACT

Six samples of 'Maluma' and two samples each of 'Hass' and 'Fuerte' avocado fruit were ripened, followed by storage under retail distribution conditions. The rate of firmness loss was then determined during a 7-day post-ripening storage period that was designed to simulate retail conditions (1 day at 2°C to simulate dispatch from the ripener; another 2 days at 2°C to simulate the time spent at the distribution center; followed by another 4 days at 7°C to simulate storage at the retail outlet and in the domestic refrigerator). From the results it would appear that 'Maluma' fruit lost less firmness than 'Hass' and 'Fuerte' during the post-ripening distribution phase. This is a surprising observation in light of the rapid rate at which 'Maluma' fruit are known to ripen after being placed into the ripening room. From the results it is clear that the current perception that 'Maluma' keeps on softening at a fast rate during the post-ripening distribution phase is unfounded.

INTRODUCTION

The 'Maluma' cultivar is a highly productive local 'Hass' type selection of which extensive plantings have been made over the last number of years. 'Maluma' fruit ripen rapidly and uniformly under commercial conditions (Lemmer & Kruger, 2015). This is considered to be a positive characteristic, but ripeners have expressed concern about the post-ripening firmness retention properties of the cultivar. The present report deals with a set of trials which aimed to measure the post-ripening firmness loss rates of 'Maluma' and compare them with those of 'Fuerte' and 'Hass'.

MATERIALS AND METHODS

During a set of early season local market ripening trials, two sets of 'Maluma' fruit and two sets of 'Fuerte' fruit from the greater Tzaneen area (Mooketsi) were

Table 1. Post-ripening firmness loss in 'Maluma', 'Hass' and 'Fuerte' samples that were stored under either local market or export simulation conditions before being ripened (Based on Day 0 – Day 7 values from small to large).

Harvest week	Storage conditions	Cultivar	Fruit origin	Count	No of fruit in 1-2 kg range day 0	Firmness change (kg)		
						Day 0 - Day 3	Day 3 - Day 7	Day 0 - Day 7
10	Local	'Maluma'	Mooketsi	20	33	+ 0,02 [a]	-0,12 [b]	-0,10 [a]
18	Export	'Maluma'	Schagen	15	19	-0,04 [b]	-0,09 [b]	-0,13 [a]
10	Local	'Maluma'	Mooketsi	18	41	-0,04 [b]	-0,10 [b]	-0,14 [ab]
24	Export	'Maluma'	Schagen	15	39	-0,16 [c]	-0,01 [a]	-0,17 [b]
14	Export	'Maluma'	Mooketsi	15	10	-0,05 [b]	-0,17 [c]	-0,22 [bc]
14	Export	'Maluma'	Mooketsi	15	18	-0,06 [b]	-0,17 [c]	-0,23 [c]
24	Export	'Hass'	Schagen	15	37	-0,07 [b]	-0,19 [c]	-0,26 [cd]
18	Export	'Hass'	Schagen	15	26	-0,18 [c]	-0,11 [b]	-0,29 [d]
10	Local	'Fuerte'	Mooketsi	20	17	-0,02 [ab]	-0,38 [d]	-0,40 [e]
10	Local	'Fuerte'	Mooketsi	18	24	-0,19 [c]	-0,29 [d]	-0,48 [e]

ripened during weeks 10-11. The fruit were dispatched to a ripening facility in Johannesburg directly after harvest. Upon arrival, the fruit were placed into the ripening room for 1 day at 6°C before ripening commenced. The fruit were then ripened at 18°C. The humidity setting was 95% and the CO_2 was vented for 10 minutes every 6 hours.

During week 14, 'Maluma' fruit from two Mooketsi orchards were used for early season export simulation and ripening trials. The avocados were stored for

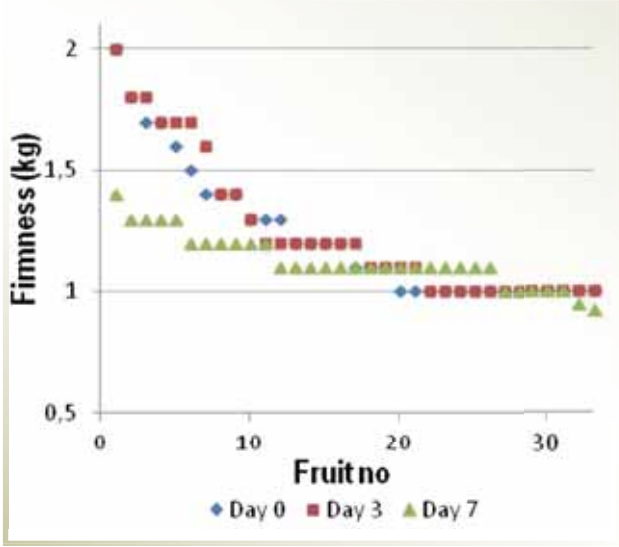

Figure 1. Firmness of count 20 'Maluma' fruit from Mooketsi that were harvested during week 10 and stored under local market conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

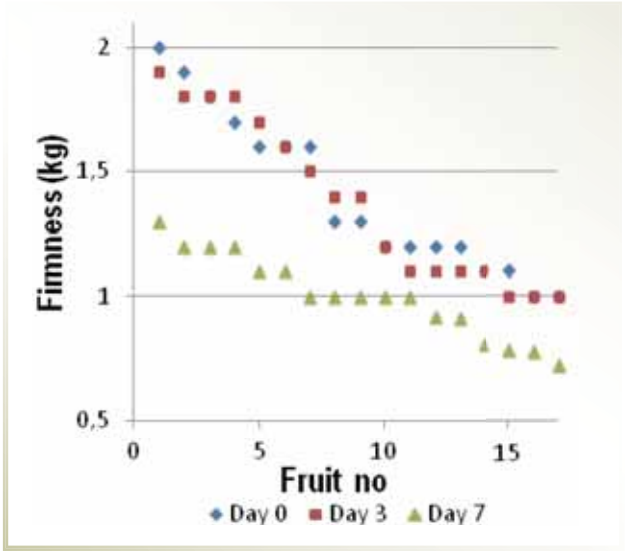

Figure 2. Firmness of count 20 'Fuerte' fruit from Mooketsi that were harvested during week 11 and stored under local market conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

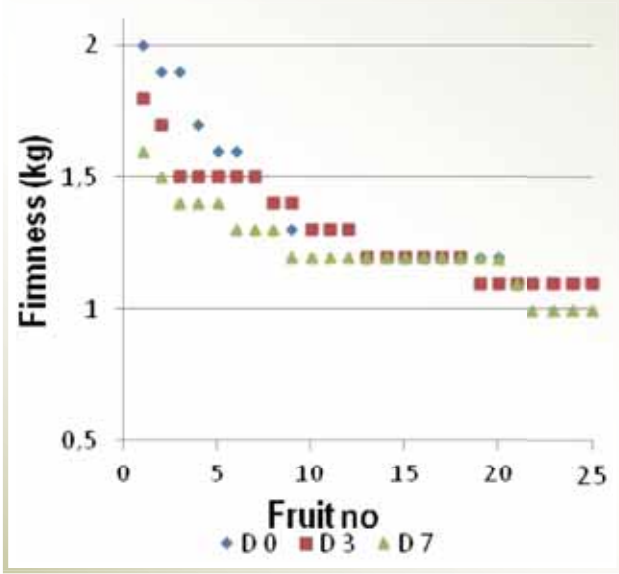

Figure 3. Firmness of count 18 'Maluma' fruit from Mooketsi that were harvested during week 11 and stored under local market conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

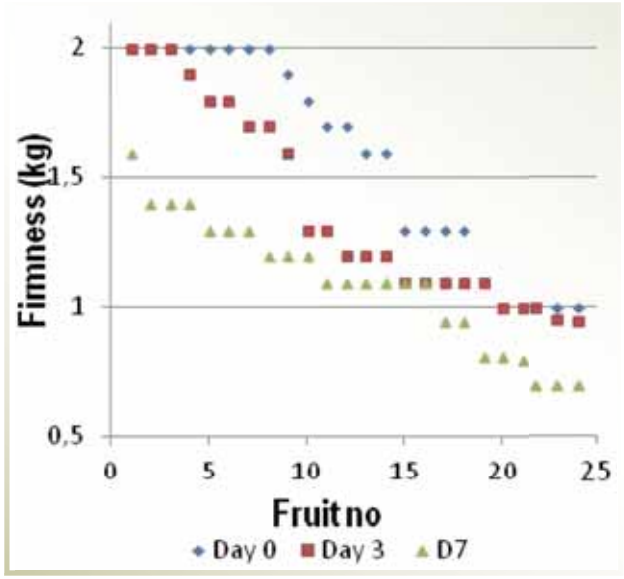

Figure 4. Firmness of count 18 'Fuerte' fruit from Mooketsi that were harvested during week 11 and stored under local market conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

30 days at 6°C before being ripened in the laboratory at 20°C.

During week 18, 'Hass' and 'Maluma' fruit from a combined experimental orchard near Nelspruit (Schagen area) were used for the first set of export simulation and ripening trials. After storage for 30 days they were ripened in the laboratory in Nelspruit at 20°C.

During week 24, a second set of fruit from the above orchard were subjected to export simulation ripening trials. However, in this case the fruit were again ripened at a commercial ripening facility in Johannesburg.

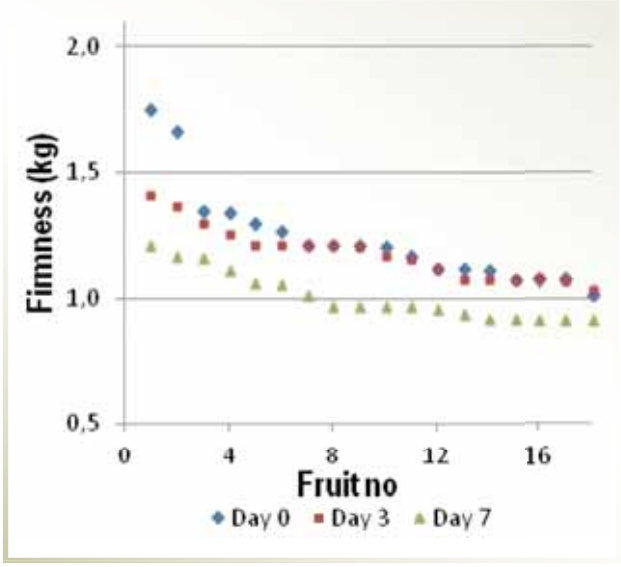

Figure 5. Firmness of count 16 'Maluma' fruit from Mooketsi (Markland orchard) that were harvested during week 14 and stored under export simulation conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

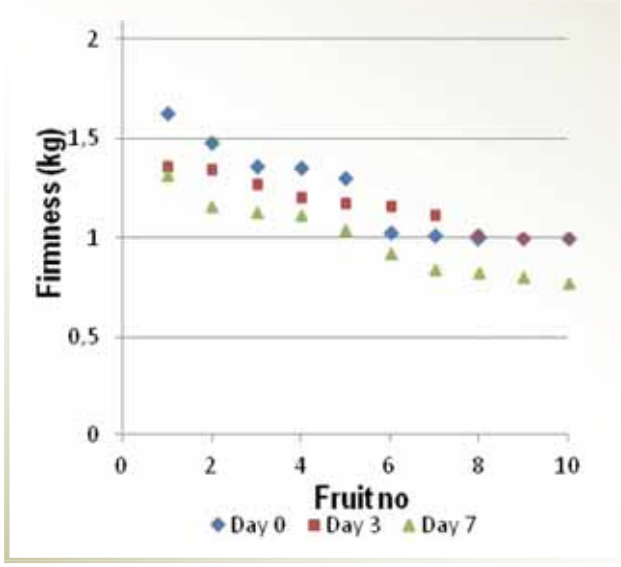

Figure 6. Firmness of count 16 'Maluma' fruit from Mooketsi (Ramadiepa orchard) that were harvested during week 14 and stored under export simulation conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

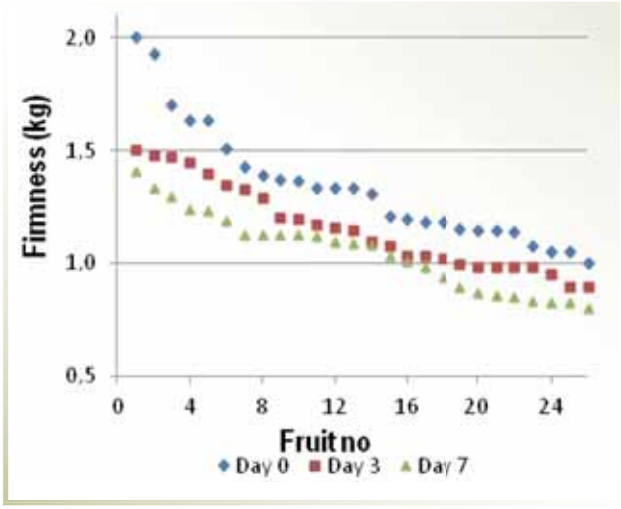

Figure 7. Firmness of count 16 'Hass' fruit from Schagen that were harvested during week 18 and stored under export simulation conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

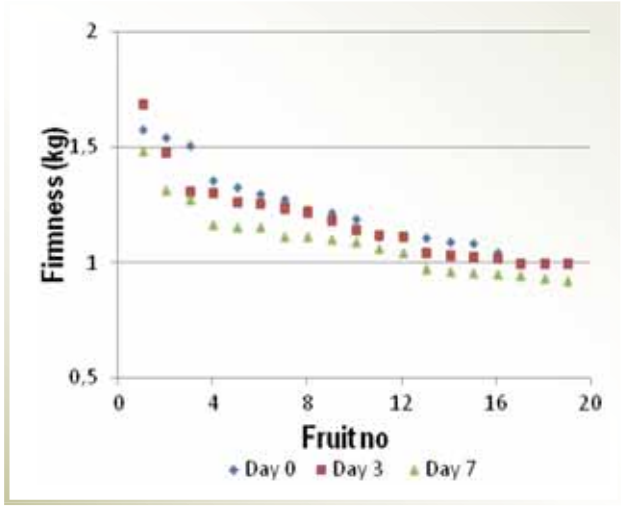

Figure 8. Firmness of count 16 'Maluma' fruit from Schagen that were harvested during week 18 and stored under export simulation conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

In all cases the ripened fruit were stored for three days at 2°C (to simulate a one day period at the ripener for cooling and packing of the fruit, followed by a two day period at the retail distribution center). The temperature was then increased to 7°C for four days to simulate the retail outlet temperature conditions and domestic storage. The firmness was determined on days 0, 3 and 4 of the distribution phase, using an electronic penetrometer.

RESULTS AND DISCUSSION

The post-ripening firmness readings of the local market 'Maluma' and 'Hass' samples that were ripened during weeks 10 and 11 are shown in Figures 1-4. Those of the 'Maluma' fruit that were sampled in the two Mooketsi orchards during week 14 and stored under export simulation conditions, are shown in Figures 5 and 6. The first 'Hass' and 'Maluma' samples from Schagen that were collected during week 18 are

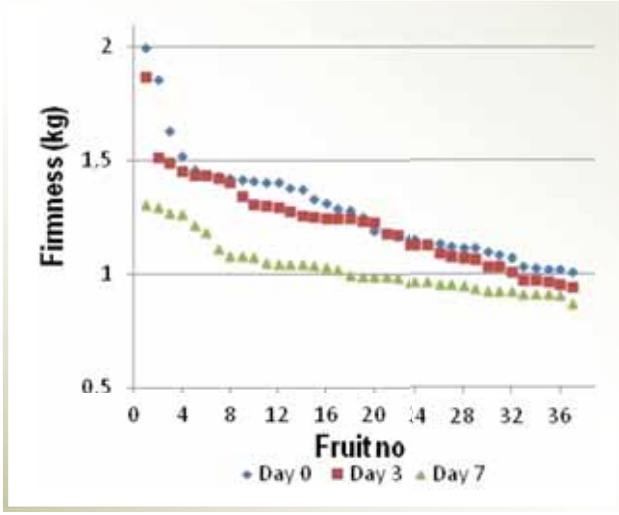

Figure 9. Firmness of count 16 'Hass' fruit from Schagen that were harvested during week 24 and stored under export simulation conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

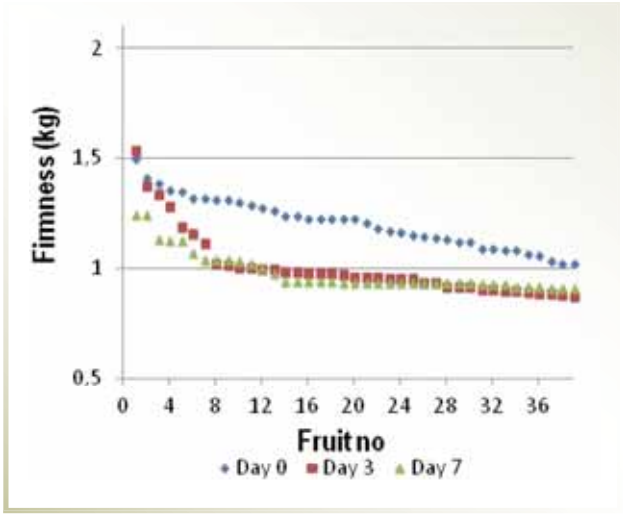

Figure 10. Firmness of count 16 'Maluma' fruit from Schagen that were harvested during week 24 and stored under export simulation conditions before being ripened. The firmness measurements were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C (Day 3) followed by another 4 days at 7°C (Day 7). Only measurements that were within the 1-2 kg firmness range on Day 0 were included in the graph. Since the firmness measurements were destructive, correspondingly ranked fruit were used for the Day 3 and Day 7 measurements.

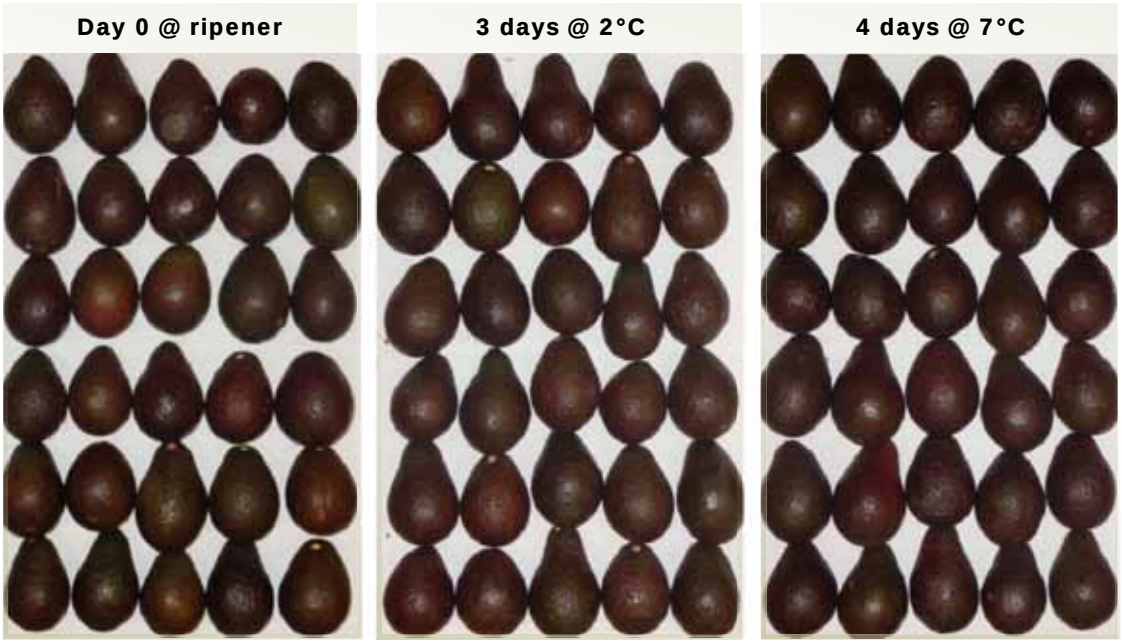

Figure 11. External appearance of count 16 'Hass' fruit from Schagen that were harvested during week 24 and stored under export simulation conditions in Nelspruit before being ripened at a commercial ripening facility in Johannesburg. The photographs were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C followed by another 4 days at 7°C.

Figure 12. External appearance of count 16 'Maluma' fruit from Schagen that were harvested during week 24 and stored under export simulation conditions in Nelspruit before being ripened at a commercial ripening facility in Johannesburg. The photographs were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C followed by another 4 days at 7°C.

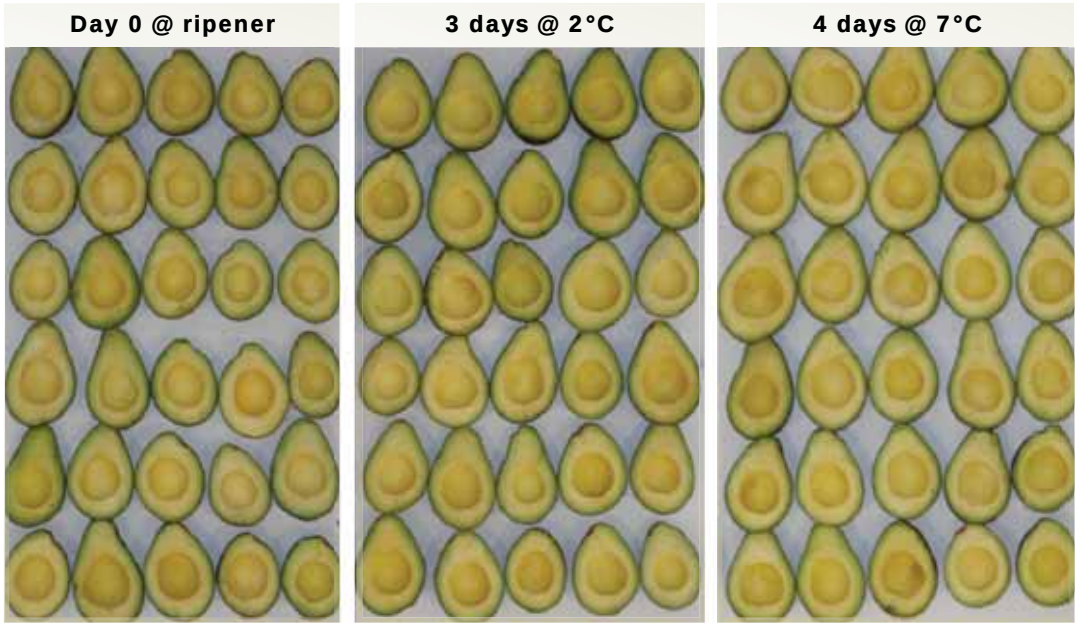

Figure 13. Internal appearance of count 16 'Hass' fruit from Schagen that were harvested during week 24 and stored under export simulation conditions in Nelspruit before being ripened at a commercial ripening facility in Johannesburg. The photographs were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C followed by another 4 days at 7°C.

shown in Figures 7 and 8, while those collected during week 24 are shown in Figures 9 and 10.

The firmness reduction rates are summarised in Table 1. From the above graphs and table it is clear that the 'Maluma' fruit lost less firmness during the post-ripening distribution phase than 'Hass' and 'Fuerte' did. This applied to both the local market and storage simulation trials. This is a surprising observation in light of the rapid rate at which 'Maluma' fruit are known to ripen after being placed into the ripening room. It would therefore appear that the softening process was effectively retarded by the retail distribution temperature regimes used in the present trial.

In terms of quality, the trial was somewhat confounded by the long pre-storage transport period from Tzaneen to Nelspruit. This emphasises our previous recommendation that the fast metabolising 'Maluma' cultivar must be packed and placed in cool storage as soon as possible after harvest (Kruger & Lemmer, 2012).

Interestingly, the post-storage transport of the fruit from Nelspruit to the ripening facilities in Johannesburg had little effect on fruit quality. The external

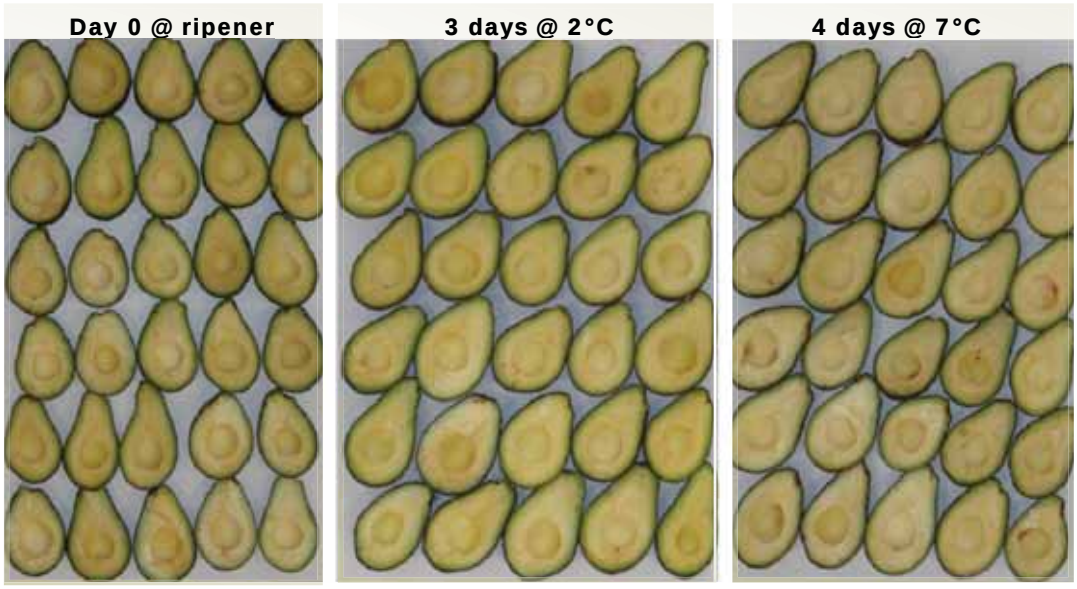

Figure 14. Internal appearance of count 16 'Maluma' fruit from Schagen that were harvested during week 24 and stored under export simulation conditions in Nelspruit before being ripened at a commercial ripening facility in Johannesburg. The photographs were taken directly after ripening (Day 0) as well as after, respectively, 3 days at 2°C followed by another 4 days at 7°C.

and internal appearance of the 'Hass' and 'Maluma' fruit from the last trial that were stored in Nelspruit and ripened in Johannesburg, are shown in Figures 11-14. As may be deduced from the photos, the 'Maluma' fruit had slightly more light bruising than 'Hass'.

From the results it is clear that the current perception that 'Maluma' fruit keep on softening at a fast rate during the post-ripening distribution phase is unfounded.

FURTHER RESEARCH

During 2015 a trial was launched to establish how soon after harvest 'Maluma' fruit must be placed into cool storage in order to avoid soft landings and the development of physiological disorders during export. This is an extremely important trial in light of the high respiration rate recorded for this cultivar (Kruger & Lemmer, 2012). The trial is to be continued during the 2016 season. A second trial was also started, aimed at determining what effects the length of the initial cool storage period and the storage temperature have on the ripening profiles and incidences of physiological and pathological disorders of the fruit.

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REFERENCES

KRUGER, F.J. & LEMMER, D. 2012. Respiration and softening rates of 'Maluma' and 'Ryan' avocados and the effect that cold chain breaks have on the ripening and quality of these cultivars. *South African Avocado Growers' Association Yearbook* 35: 12-20.

LEMMER, D. & KRUGER, F.J. 2015. Comparison of the black cold damage sensitivity and ripening uniformity characteristics of the 'Maluma' and 'Hass' avocado cultivars. *South African Avocado Growers' Association Yearbook* 38: 19-26.