Ancient fruit needs new guidelines

Packed with vitamins, minerals and anti-oxidants, pomegranates' status as a superfood is steadily growing. The increased demand, however, makes it essential to study this fruit in depth to provide science-based post-harvest solutions for industry.

SOUTH AFRICA COMPETES with countries such as Chile, Australia, Peru and Argentina to supply the off-season demands for pomegranates of consumers in the Northern Hemisphere. As such, the long supply chain is key to maintaining the commercial viability of this crop. Therefore, harvesting fruit at the optimum maturity level when quality (and optimum nutritional and medicinal values) can be ensured is essential for this specialty crop.

In the interest of establishing and maintaining a competitive edge in the global market, there is also a need for an index of common disorders that compromise export quality, as well as for effective post-harvest management in the areas of packaging, storage and transport. This affects the processing options, packaging and marketability of the whole fruit in the overseas markets.

Prof. Umezuruike Linus Opara, who holds the DST-NRF South African Research Chair in Post-harvest Technology in the Department of Horticultural Science at Stellenbosch University, is recognised globally as the leading researcher on pomegranate-related post-harvest technology. His multi-disciplinary research team leads the way in terms of post-harvest practices that improve the handling, packaging and marketing of pomegranate fruit.

As part of a study funded by the Post-Harvest Innovation (PHI) Programme and the South African Association for Pomegranate Growers (POMASA), Prof. Opara and his team spent the past two years studying two of the South African pomegranate industry's most pressing research needs: science-based tools to determine fruit maturity (fruit readiness for harvest) and improved post-harvest handling management to ensure reduced post-harvest losses and prolonged shelf life.

"The aim of this study was to develop appropriate harvest maturity indices, define quality disorders, and characterise the storage potential and shelf life for three commercial pomegranate cultivars grown in South Africa, all in the interest of good eating quality and minimised storage losses after long supply chain handling," explains Prof. Opara.

Working with Prof. Opara were Dr Olaniyi Fawole and Elrita Venter.

1 Prof. Opara and his multi-disciplinary research team (back from left) Matia Mukama, Dr Alemayehu Ambaw Tsige, Dr Olaniyi Amos Fawole, Prof. Umezuruike Linus Opara and Dr William Mavengere; (front from left) Karen Munhuweyi, Tatenda Kawhena and Dr Rebogile Mphahlele.
2 An example of cartons currently used to export pomegranates.

Methodology

The researchers studied 'Acco', 'Herskowitz' and 'Wonderful' pomegranates grown in a commercial orchard in Wellington before and during the 2015/2016 harvest.

Measurements of fruit length and width were done bi-weekly, from 28 to 132 days after full bloom (DAFB). Five fruit harvests were performed per cultivar and fruit from each harvest were stored at 5°C for six weeks, followed by storage at 20°C for five days to simulate shelf-life conditions.

To determine the physico-chemical properties of pomegranate juice, arils were extracted manually followed by juice extraction using a blender.

The researchers set four objectives.

Objective 1: Develop a predictive optimum maturity index for commercially grown pomegranate cultivars in South Africa.

Key results:

- All three pomegranate fruit cultivars followed a linear growth pattern over the study period and characteristic fruit shapes developed around 110 DAFB for all three cultivars.
- Fruit skin colour was not a good indicator of aril colour during fruit growth and maturation, and sugar concentration (TSS) fluctuated, particularly for 'Herskowitz' and 'Acco'.
- All cultivars were susceptible to a wide range of pre-harvest fruit disorders and defects, but cracking affected only 'Herskowitz'. 'Herskowitz' was also the most susceptible to crown rot, with higher incidence occurring later during harvest.
- Based on the combination of data on fruit physico-chemical properties, sensory analysis and incidence of storage disorders, the optimum harvest maturity coincided with 123 to 132 DAFB for 'Acco', 133 to 137 DAFB for 'Herskowitz' and later than 134 DAFB for 'Wonderful' pomegranates.

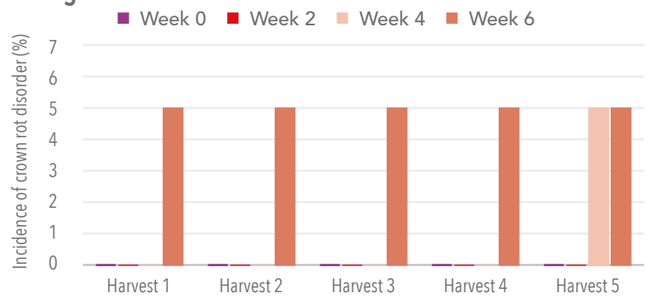
Objective 2: Characterise storage potential and shelf life for commercial pomegranate cultivars in consideration of the long supply chains.

The greatest determining factor of storage practices is susceptibility to post-harvest disorders. Fruit with retained flavour is of no use if it exhibits disorders such as crown rot, given the risk that such disorders may spread easily from infected to uninfected fruit.

Key results:

- Based on observations of post-harvest disorder development, the first three harvests of 'Acco' and the first two harvests of 'Herskowitz' would be ideal, as no crown rot incidence was observed.

Figure 1: Crown rot disorder incidence in 'Wonderful'



Incidence of post-harvest crown rot disorder in 'Wonderful' pomegranates. Fruit were harvested at five different periods, with each harvest stored for six weeks at 5°C and five days of shelf life at 20°C.

PROJECT TITLE
Integrated post-harvest innovative solutions for the South African pomegranate fruit sector

PRINCIPAL INVESTIGATOR
Prof. Linus Opara

CONTACT DETAILS
+27 (0)21 808 9242
opara@sun.ac.za

DURATION
Two years

PHI PROGRAMME & INDUSTRY CONTRIBUTIONS
R792 830 & R209 070

LEAD INSTITUTION
Stellenbosch University (Department of Horticultural Sciences)

BENEFICIARY
The South African pomegranate industry

FOCUS AREA
Post-harvest physiology

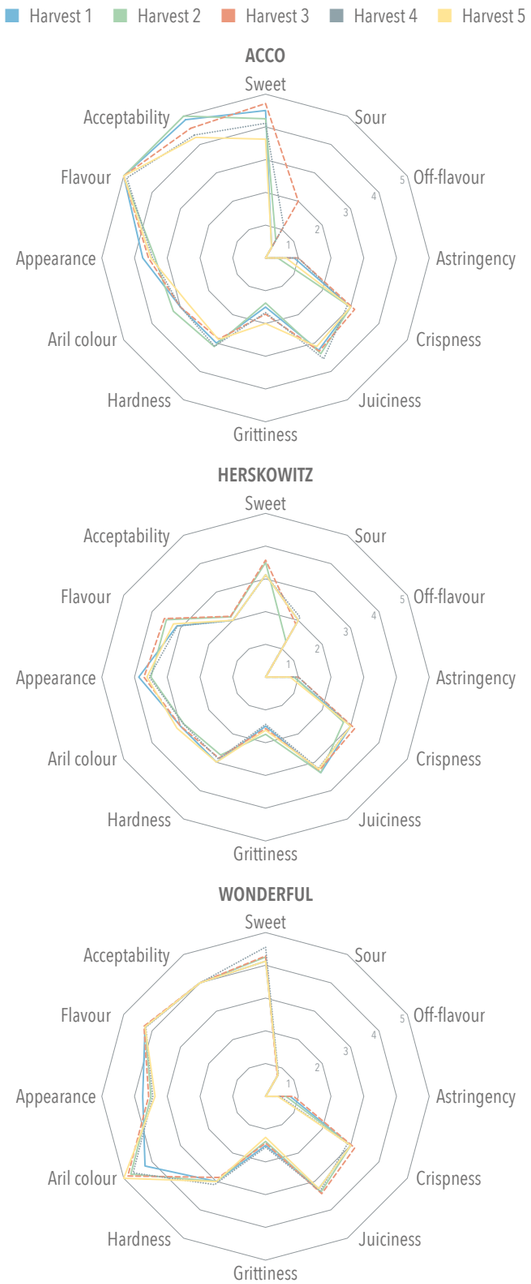
HUMAN CAPITAL DEVELOPMENT
One post-PhD student, one PhD student and two MSc students

PUBLICATIONS
One

PRESENTATIONS AND PAPERS
Six

Figure 2: Sensory properties of pomegranate

Sensory properties of pomegranate 'Acco', 'Herskowitz' and 'Wonderful' after six weeks of storage at 5°C and five days of shelf life at 20°C. The radar plot shows averaged sensory scores (scale = 0–5; n = 8).



- The first four harvests of 'Wonderful' exhibited mild crown rot in the sixth week of storage although the incidence was lower than in 'Acco' or 'Herskowitz'.
- 'Herskowitz' was most susceptible to post-harvest crown rot during storage and shelf life, with higher incidence occurring in late harvested fruit.

Objective 3: Index and define quality disorders of South African grown pomegranates

An array of pre-harvest fruit quality disorders were tracked during fruit maturity development, with differences noted between cultivars. The study focused on common disorders that compromised fruit quality standards such as sunburn/bleaching, cooking disorder (where fruit arils are cooked on the inside), bruising and cracking.

Key results:

- The incidence and severity of pre-harvest disorders in commercial pomegranates is cultivar specific. All cultivars were susceptible to a wide range of pre-harvest fruit disorders and defects.
- Cracking only affected 'Herskowitz'.

Objective 4: Improve fruit cooling rate and quality by optimising multi-scale packaging of pomegranates.

The aim was to evaluate the cold chain performance of some of the frequently used ventilated cartons and internal liners during forced-air cooling and cold-storage in terms of resistance to airflow, cooling characteristics, energy efficiency and fruit quality.

Key results:

- Post-harvest life of pomegranate fruit is significantly affected by relative humidity (RH). Maintaining high RH during storage best preserved fruit colour, texture and chemical fruit quality attributes. Low ambient RH conditions led to excessive weight loss and reduced visual quality due to a shrivelled and deformed appearance.
- Fruit packaged without liners lost about 17% more weight during precooling compared to fruit packaged with liners. However, packaging fruit inside a liner offered up to 50% greater resistance to air flow than fruit packaging with no liner. Consequently, the use of liners delayed fruit cooling and increased energy consumption.

Conclusion

Pomegranates are highly susceptible to weight loss and decay during post-harvest handling and storage, and inadequate cooling and packaging could significantly affect their post-harvest quality and ultimately their competitiveness in the export industry.

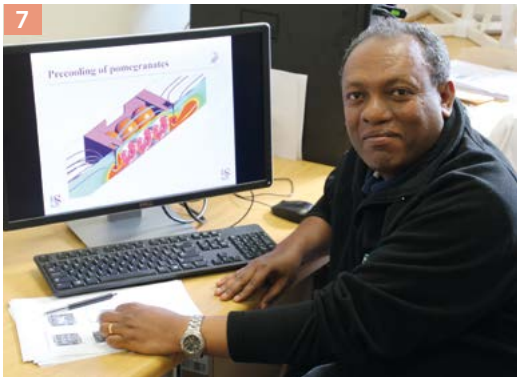
Pomegranate fruit is non-climacteric and thus cannot continue the ripening process after being harvested. Harvesting pomegranates at the wrong time may result in fruit that looks good, but has poor aril colour intensity and unacceptable flavour. On the other hand, fruit harvested too late are more susceptible to post-harvest disorders and diseases. This study identified the optimum harvest maturity for three pomegranate cultivars in South Africa.

In terms of packaging, the study found that relative humidity, cooling, packaging design and stack orientation all have an effect on

1–5 Pomegranate pre-harvest disorders: (**1**) cracking, (**2**) abrasions, (**3**) false codling moth, (**4**) sunburn, and (**5**) scald.

quality. Although the use of liners minimised fruit weight loss, it increased resistance to airflow, precooling time, energy consumption and cooling costs.

Cold room humidification could potentially mitigate extreme moisture loss and maintain fruit quality while achieving faster cooling. However, the effect of humidification on the mechanical integrity of fireboard cartons will have to be analysed before this avenue can be recommended.



1 Matia Mukama (right), posing here with Prof. Opara, investigated how package design affects airflow distribution and cooling rate during forced air cooling of produce.
2 Dr William Mavengere assisted in developing a harvest maturity index for commercial pomegranate fruit cultivars in South Africa.
3 Dr Rebogile Mphahlele investigated the chemical and bioactive compounds extracted from different fruit fractions of 'Wonderful' pomegranates. The results of the study highlighted the impact of methods of extraction on the quality of pomegranate juice.
4 Karen Munhuweyi is developing active packaging for whole and fresh-cut pomegranate fruit that can control microbial spoilage.
5 Value-added material from pomegranate fruit waste with high nutritional content and potential for use in food and beverage industries.
6 Dr Olaniyi Amos Fawole determines the nutritional content of pomegranate arils.
7 Dr Alemayehu Ambaw Tsige's research includes optimising the design and performance of ventilated packaging using computational fluid dynamics, exploring energy saving schemes during refrigerated storage of perishables, and spray applications of plant control agents.