Post-harvest Physiology and Non-destructive Fruit Quality Assessment Techniques

The secret's in the cells

Unlike beauty that is skin-deep, mealiness in pears develops at cellular level. This could be the secret to spotting mealied 'Forelle' pears before they reach the consumer.

The development of mealiness is a pre-existing condition in some 'Forelle' pears.

ONE OF LIFE'S DISAPPOINTMENTS is to bite into a fine-looking pear and instead of the moist, crisp juiciness you were expecting, you have a mouthful of soft, dry and mealy flesh!

It is this kind of experience that makes consumers think twice when buying fruit, and one that lands commercial pack houses in hot water. Every year, carton upon carton of mealy pears are turned down, leaving pack houses to pick up the tab.

'Forelle' pears are particularly prone to mealiness, especially when they are not stored under cold enough temperatures for long enough. The mealiness is usually at its worst after six to eight weeks of cold storage at -0,5°C and ripening. As the pears become less mealy the longer they are stored, the industry prescribes a mandatory cold storage period of about 12 weeks at -0,5°C for all export and locally marketed pears.

This, however, can be a logistical challenge at the best of times. Such a long storage period influences market availability and the commercial success of South African pears, as it leads to our fruit reaching the European markets after exports from Argentina, Chile, New Zealand, Brazil and Australia. More frustratingly, extended cold storage still does not guarantee that consumers will have an enjoyable eating experience.

Until recently, the only way to test for mealiness was to cut open a sample of fruit after the pears have ripened.

TAKING A CUE FROM APPLES

Are long storage periods actually the answer to curb mealiness in 'Forelle' pears? Can mealiness be detected without having to sacrifice any fruit? Is it a pre-existing condition, or does it develop because of the wrong storage conditions?

To answer these questions, enter Dr Elke Crouch of the Department of Horticultural Science at Stellenbosch University, an expert in the study of cell walls. Dr Crouch took her cue from research on apples. This work has showed that textural disorders, like mealiness, are related to cell size and shape and to the calcium that glues the cells together in the middle lamella.

Research into mealiness started in 2011 with support from the export company, Tru-Cape Fruit Marketing (Pty) Ltd, and was jointly financed by the Post-Harvest Innovation Programme and HORTGRO^{Science}.

The questions did not only interest Dr Crouch on a purely academic level. She also wanted to find a practical and non-invasive way to detect a predisposition for mealiness in pears without damaging the fruit. Her choice fell on near-infrared (NIR) technology and X-ray computed tomography (X-ray CT) scanning methods.

"Mealiness and other internal defects can potentially be detected based on the fruit's ability to absorb infrared radiation or X-rays," explains Tavagwisa Muziri, who has devoted his PhD studies in horticultural science at Stellenbosch University to the subject.

NIR spectroscopy works with the ability of radiation to interact with matter, and is based on molecular overtone and combination vibrations. It is possible to test a sample of up to 1cm thick. Although not a particularly sensitive technique, NIR can be useful in probing bulk material with little or no sample preparation. In turn, X-ray CT scanning uses a movable X-ray source and detector assembly to accumulate data from more than a hundred thin digital slices of the sample material.

It has been known since 1999 that X-ray computed tomography can be used to monitor internal changes in fruit. "Because no single technology has yet been developed to cover all current and future applications in production, storage and retail of fresh produce, we tried to synergise efforts to develop ideal quality determination techniques," says Mr Muziri.

SHEDDING LIGHT

Following detailed laboratory analyses coupled with fieldwork that linked pre-harvest effect with post-harvest quality, the research team established that mealiness is a pre-existing condition in some 'Forelle' pears.

Other findings that shed light on the pear conundrum include:

- Mealiness development starts in the neck and extends downwards through the flesh of the fruit.

'FORELLE' PEARS IN FOCUS

This smallish pear has a distinctively sweet aroma and taste. Its characteristic red freckles sets this variety apart.

Together with 'Packam's Triumph', 'Forelle' pears are the second most produced pear in South Africa per volume. In 2012, more than 3 000ha were planted with 'Forelle' pears in South Africa.

Almost three million cartons were exported in 2012.

1 A mealy 'Forelle' pear does not release juice when squeezed. When the mealy tissue is chewed, no juice will be released either. There is still no mechanism or instrument for detecting mealiness in intact fruit. All mealiness determinations are done by the mouth / taste (organoleptically) or visually by squeezing wedges of tissue – both destructive techniques.

PROJECT TITLE
Shedding light on mealiness in 'Forelle' pears

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DURATION
Two years

PHI-2 CONTRIBUTION
R241 284

LEAD INSTITUTION
Stellenbosch University (Department of Horticultural Science) and Tru-Cape Fruit Marketing (Pty) Ltd

BENEFICIARY
The deciduous fruit industry

FOCUS AREA
Post-harvest treatments and fruit quality disorders

HUMAN CAPITAL DEVELOPMENT
One PhD student

PRESENTATIONS AND PAPERS DELIVERED
Six

X-ray CT scanning is currently only available for experimental purposes in the fruit industry. The wood industry has already shown that it can be applied on a large scale.

- Its development is associated with larger-celled fruit and highly porous fruit with large air spaces around the cells.
- In 'Forelle', mealiness development seems to be linked to a high total soluble sugar content.
- It is possible to accurately determine the total soluble solids (TSS) in fruit with the help of non-destructive NIR spectroscopy methods. Based on the TSS, a non-destructive mealiness model can be developed.
- Such a TSS-based model is more accurate on the sun-exposed side and the neck area of the fruit.
- NIR can also be used to non-destructively detect mealiness immediately after fruit is taken out of cold storage. This means that pears can be sorted before they reach the consumer.
- X-ray computed tomography can detect mealiness either after harvest, cold storage or when the condition is fully developed. The air spaces in the fruit, which differ in volume and number between healthy and mealy fruit, are the clues.
- This technique could be developed further to measure mealiness at harvest, after storage and after ripening.


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THE WAY FORWARD

Despite the insights gained, questions that still baffle the researchers include:

- Do some bearing positions produce more mealy fruit than others?
- Could the findings be of value for the 1-MCP (SmartFresh™) 'Forelle' Early Market Access programme where mealiness/ripening is inhibited from developing, and where the remainder of the fruit could be used in ripening programmes where mealiness will not be an issue?

Dr Crouch hopes that their findings that larger cells facilitate the development of mealiness will guide producers to adopt practices that result in firmer and more compact fruit. Also, she believes their research will eventually lead to technologies that can grade fruit for mealiness development at wholesale dispatch points, prior to shipment or before it reaches the consumer.

"These efforts are bound to improve the competitiveness of the producer, reduce claims and increase export volumes and income," she adds.

Putting these into practice is still a challenge.

"NIR grading is already used sporadically in the industry," says Dr Crouch. "To test if our model can accurately determine mealiness and TSS on a large scale, we will need to recalibrate the machines in use over the course of a few seasons and then on a commercial scale."

X-ray CT scanning is currently only available for experimental purposes in the fruit industry. The wood industry has already shown that it can be used to sort wood on a large scale.

"As data processing capabilities increase, it will become possible to process the immense volumes of information gathered by the X-ray CT scanning of fruit on a larger scale," says Dr Crouch. She believes that such technology may become par for the course on sorting lines in the next five to ten years.

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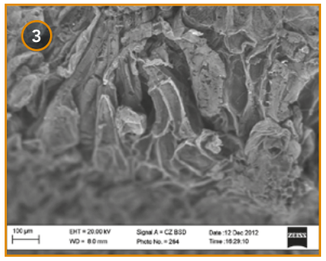
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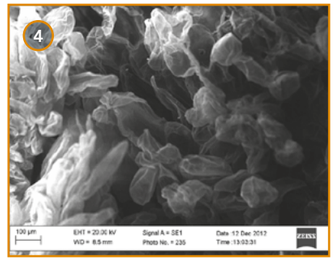
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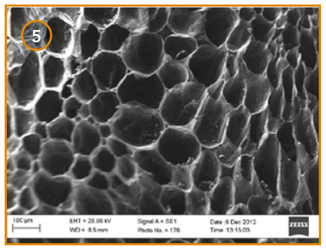
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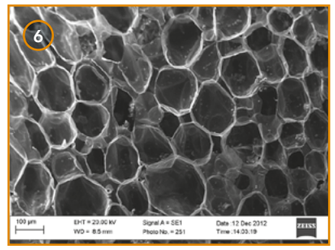
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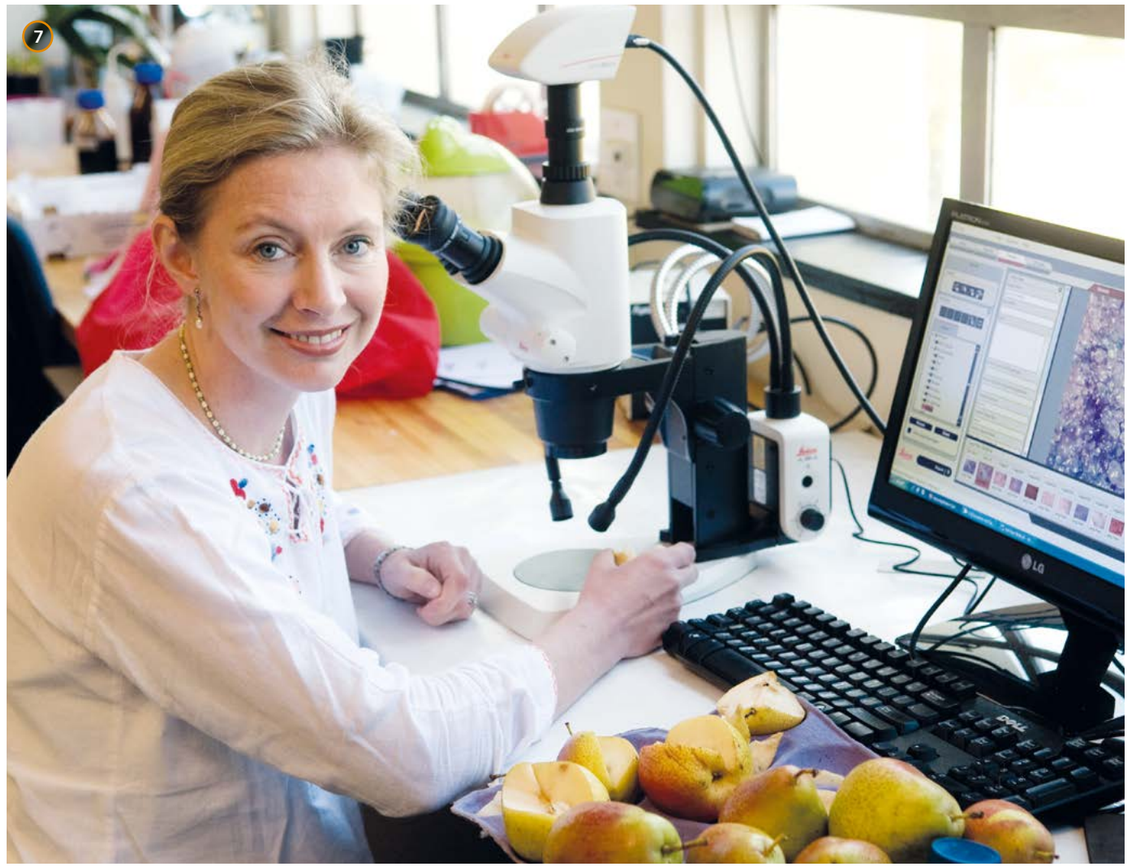
1 Dr Elke Crouch and Tavagwisa Muziri.
2 Tavagwisa Muziri uses NIR technology, a practical way to detect a predisposition for mealiness without damaging the fruit.
3-4 Scanning electron micrographs of non-mealy fruit cells [3], mealy fruit cells [4]. Non-mealy fruit cells show breakage in the cell walls, which is absent in mealy cells.
5-6 Images taken at 100x magnification: the cells are closely packed with small intercellular spaces [5]; the cells have relatively larger intercellular spaces [6].
7 Dr Elke Crouch.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