Post-harvest pathology, food safety and disease control

Anoint the avocado

Thyme oil used in new-generation packaging not only keeps avocados safe from disease, it also extends their shelf life.

2014 18

The combination of thyme oil in volatile phase with MAP can maintain fruit quality for up to 18 days at market shelf by increasing the antioxidant pool in the mesocarp.

SOUTH AFRICA'S EXPORT AVOCADOS are popular for their nutritional properties, such as being rich in vitamins and high in fibre. Sadly, their shelf life is relatively short. Their quality and marketability are also much affected by anthracnose, a common post-harvest disease.

Producers have pre- and post-harvest options to combat anthracnose. Before harvesting, the fruit can be sprayed with copper oxychloride to control anthracnose. However, repeated applications throughout the season can cause a build-up of copper residues on the fruit. It can also affect the beneficial fructoplane population on the fruit surface.

Post-harvest, the synthetic fungicide, prochloraz, is commercially used to control anthracnose in South Africa, Australia and New Zealand. This option is also not without its problems. Disposal of the fungicide solution that was used for dip treatment is a major problem for commercial pack houses. Additionally, due to the development of fungicide resistant strains, post-harvest fungicide application is not considered a long-term solution for the fruit industry.

On the other hand, consumers demand attractive fruit, free of diseases and toxic residues and with a longer shelf life. Importing countries furthermore enforce strict regulations regarding the minimum residue levels allowed on the skin of the fruit.

In the past, wax coatings such as carnauba or polyethylene were commonly applied to fruit. It is essential that the wax coating does not leave any residues or influence the natural glossiness, eating quality and characteristic flavour of the fruit. The European Union (EU) does not allow morpholine in wax emulsions and can remove the application of wax for fruit such as avocado and citrus, due to increasing green consumerism and consumer demand for organic fruit.

All these factors have stimulated the search for new alternative solutions to replace fungicide application and wax coating for avocados.

ENTER ESSENTIAL OILS

The general antifungal activity of essential oils is well documented. A combination of essential oils with a commercial coating (Avoshine®) was previously recommended as an acceptable post-harvest treatment to control anthracnose in avocados. Unfortunately, the organic niche markets, specifically in developed countries, prefer fruit without coatings.

However, the vapour phase of essential oils presents viable options. It requires low concentrations and is more effective than the liquid phase application. Interestingly, it does not affect the smell and taste of foodstuff.

The vapour application requires packaging that creates an environment in which the vapour can be effective. Therefore, the application of essential oil has to be investigated in combination with modified atmosphere packaging (MAP). MAP was shown to reduce the ripening process by inhibiting the ethylene action in avocados, thereby extending their shelf life. In South Africa, the current practice is that avocados are treated with prochloraz dip fungicide and packed in Fresh Mark™ bags.

Against this backdrop, Prof. Dharini Sivakumar, from the Department of Crop Sciences at the Tshwane University of Technology (TUT), headed a Post-Harvest Innovation Programme study to investigate the effect of different essential oils – in vapour phase and at low concentration – in combination with MAP on:

- Anthracnose disease incidence and modes of action of the essential oils on decay control.
- Incidence of physiological disorders, physicochemical parameters (weight loss, firmness, colour) and sensory properties.
- Bioactive compounds and antioxidant activity, in order to determine the overall fruit quality of three commercial avocado cultivars, namely 'Hass', 'Fuerte' and 'Ryan', during domestic marketing temperature storage (10°C) for 18 days and thereafter up to 10 days at market shelf conditions of 20°C.

OUTCOME OF THE STUDY

The use of a MAP (bi-orientated) carrier bag in combination with thyme oil sachets treatment significantly reduced the incidence and the severity of anthracnose, grey pulp, vascular browning, weight loss and loss of fruit firmness. In addition, it showed acceptable taste, flavour, texture and higher overall acceptance. The total phenolic compounds, flavonoid contents and antioxidant activity, after ripening at 25°C followed by cold storage at 10°C, were also higher.

Thyme oil sachets in a MAP bag induced the activities of defence enzymes and enhanced the antioxidant enzymes, such as superoxide dismutase and catalase. These results confirm that the effects of thyme oil on anthracnose in avocados are due to the elicitation of biochemical defence responses in the fruit and inducing the activities of antioxidant enzymes.

"Thyme oil can be a cost-effective alternative to a fungicide like prochloraz," says Prof. Sivakumar. "Thymol essential oil is already used as a food preservative. The US Food and Drug Administration lists it and thyme, the herb, as food for human consumption, and recognise them as Generally Regarded as Safe (GRAS) food additives."

To transfer the new knowledge, Prof. Sivakumar held an information day at TUT for farmers, retailers, post-graduate students and researchers. They also compiled a booklet to introduce best post-harvest practices for avocados for emerging farmers.

PROJECT TITLE
Developing environmentally friendly post-harvest disease control methods for peaches and avocados

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DURATION
Two years

PHI-2 CONTRIBUTION
R285 000

LEAD INSTITUTION
Tshwane University of Technology (Department of Crop Sciences)

BENEFICIARY
The deciduous and subtropical fruit industries

FOCUS AREA
Post-harvest pathology, food safety and disease control

HUMAN CAPITAL DEVELOPMENT
Two MTech and two post-doctoral students

PRESENTATIONS AND PAPERS DELIVERED
One

PUBLICATIONS
Four

1 Prof. Dharini Sivakumar.
2 Avocados infected with anthracnose disease.

Essential oils and their components are attracting increasing interest due to their natural origin, volatility, relatively safe status, low risk of developing resistance in decay-causing pathogens, wide acceptance by consumers, and eco-friendly and biodegradable properties.

MORE POWER TO THE PEACH

Post-harvest diseases such as grey mould rot, blue mould rot, Rhizopus rot and brown rot affect the shelf life, fruit quality and marketability of South Africa's export peaches. Some pack houses use a synthetic fungicide (Rovral®) to control post-harvest decay, which may increase up to 50% without treatment.

The use of synthetic fungicides to treat peaches is subject to the same challenges as in the case of avocados. In addition, synthetic fungicides are expensive for small-scale farmers and peaches are not recommended for aqueous sanitation. The application of physical treatments, such as hot water and vapour heat, consumes a lot of energy and requires costly equipment.

For these reasons, there is an urgency to find new alternatives to synthetic fungicides and to improve the technologies that will extend shelf life. Novel technologies, such as adding essential oils as active agents inside the packaging, wax coatings, edible coatings, edible films or active labels have shown promising results. Peaches, however, are not subjected to waxing in the packing line.

Application of nanotechnology in food packaging has been shown to extend the shelf life of food products. Incorporating nanoparticles in films has been proven to provide protection against microbial decay due to their improved antimicrobial properties, thereby altering surface wettability and hydrophobicity of the films.

The fresh produce industry prefers to replace petrochemical-based films with films made of biodegradable, environmentally friendly materials. The biodegradable films are made from natural biopolymers such as chitosan, starch, proteins, corn and whey proteins. The antimicrobial property of chitosan film was reported to improve with oregano essential oils and thyme oil. Nanocrystalline boehmite alumina n-AlO(OH) has been reported to improve the mechanical properties of synthetic films, such as low- and high-density polyethylene. Antimicrobial activity of alumina (Al_2O_3) nanoparticles was reported against human and foodborne pathogens for clinical application.

Based on these previous findings, the researchers set out to study the effect of chitosan lidding film and thyme oil sachets, chitosan lidding film incorporated with (1%) boehmite alumina nanoparticles and thyme oil sachets on the incidence and severity of post-harvest diseases and changes in fruit quality and biochemical parameters in peaches packed in a polyethylene terephthalate (PET) punnet and stored at 0,5°C, 90% RH for seven days and thereafter held at simulated market shelf conditions for five days at 15°C, 75% RH.

OUTCOME

Chitosan lidding film and thyme oil sachets teatment maintained 56,43% thymol and 38,7% caryophyllene (head space volatiles) within the punnet, while the active ingedients of thyme oil vapour were moderately lower within the head space of chitosan film-boehmite alumina and thyme oil sachets treatment. Chitosan film-boehmite alumina lidding film and thyme oil sachets treatment maintained a slightly higher O_2/CO_2 ratio (head space gases) than the chitosan film and thyme oil sachet treatment. Chitosan film-boehmite alumina lidding film demonstrated an increased water vapour transmission rate to the chitosan lidding film. The chitosan lidding film and thyme oil sachets treatment or chitosan film-boehmite alumina lidding film and thyme oil sachets treatment delayed colour changes and maintained the SSC/TA, ascorbic acid content, total phenolic compounds, and antioxidant activity during post-harvest storage. Panellists preferred fruit from chitosan boehmite alumina lidding film and thyme oil treatment.

The results suggest that the combination of chitosan lidding film and thyme oil sachets can be recommended as a suitable post-harvest treatment due to its effectiveness in controlling post-harvest diseases and retaining fruit quality and sensory properties, notably the peach aroma.


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Results suggest that chitosan lidding film and thyme oil sachets can be a suitable treatment in controlling post-harvest diseases.


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1 Dr Shittu worked as a post-doctoral student on the peach project.
2 Bevly Mampolo and Dr PS Sellamuttu with the GC/MS (gas chromatography and mass spectrometry) equipment used in the study.
3 Decayed peaches cause substantial losses in the post-harvest value chain.
4 Researchers busy preparing peaches for the artificial inoculation trails.