

Smart solution to plum conundrum

What to do when you know your export plums arrive at their best when stored at different temperatures during shipping, but your overseas market dictates a strict one-size-fits-all cold-steri approach? You turn to science for answers.



1 Handré Viljoen, project leader.
2 Dual temperature plum cultivars, such as 'Sapphire', require cold-storage at -0,5°C for 3–10 days. This temperature is then raised to 7,5°C for 5–7 days and then cooled down again to -0,5°C until marketing. This prevents storage disorders, such as internal browning, that would develop at prolonged temperature of -0,5°C. The period at 7,5°C allows the fruit to recover from permanent cell damage. Cold steri markets, however, require these plums to be stored at -0,55°C for 22 days. Inevitably, this protocol is too harsh for most dual temperature cultivars, resulting in internal browning and decreased fruit quality.

STORING AND SHIPPING plums is a constant play between ensuring that cartons of fruit do not arrive at their destination in a hard, unripe state, or too ripe. Then there is the worry of plums developing unsightly internal browning, or a condition called gel breakdown.

Back in the late 1930s, a technical advisor working for the Perishable Products Export Control Board, Dr AJ Smith, was the first to suggest using a dual temperature system to transport South African plums. Thanks to further research, the fruit industry now has specific protocols and temperature regimes to guide the cooling and storing of most cultivars.

In recent years, trade rules and regulations have added to the complexity of exporting plums. Worldwide, international fruit markets are increasingly concerned that harmful



diseases and pests, such as fruit flies, could inadvertently be shipped from one country to another along with imported boxes of plums, table grapes or pears.

In reaction, some countries have imposed strict phytosanitary regulations on fruit exporters, forbidding the importation of certain plants, insects or their larvae.

Cold sterilisation, which effectively freezes and kills these pests, is one way to meet phytosanitary regulations. South Africa may, for instance, export some plum cultivars to the USA, but only under strict cold sterilisation treatment conditions. The prescribed uninterrupted storage at -0,5°C for 22 consecutive days is, however, much too harsh for most plum cultivars and causes chilling injury that shows up as internal flesh browning or gel breakdown around the stone. This adds up to a shorter shelf life, the rejection of shipments, complaining customers and financial losses all round.

A solution is needed to ensure that the local plum industry does not lose out on lucrative markets because of the interplay between regimes and regulations. Therefore, fruit industry leader Hortgro Science launched a study to test the value in using the synthetic produce quality enhancer SmartFresh™ as part of adapted temperature regimes that satisfy phytosanitary regulations. The product has been used successfully in recent years to reduce gel breakdown and to extend storage life of the dual-temperature plum cultivar 'Songold'.

Preliminary results showed promise but highlighted that not all dual-temperature cultivars were going to react similarly to SmartFresh™. The research was therefore extended in 2014 through a Post-Harvest Innovation Fund project conducted by ExperiCo.

"We needed more than just positive results," says ExperiCo's fruit physiologist Handré Viljoen. "The specific risk indicators for each



cultivar have to be known before they can be exported to phytosanitary markets using SmartFresh™."

Objectives and methodology

The research project, jointly funded by the PHI Programme and industry, allowed the ExperiCo team to test the five top dual-temperature plum cultivars exported from South Africa: 'Fortune', 'African Rose', 'Sapphire', 'African Pride'/'Sunkiss' and 'Ruby Red'.

The mission was clear:

- Establish if SmartFresh™ application and warming treatments applied during cold-storage can counter quality losses which may develop during cold-steri treatment of traditional dual-temperature stored plums.
- Provide essential information on how to handle and store dual-temperature plums for cold-steri markets.
- Develop specific cold-storage protocols for each cultivar.

Trials were conducted over three seasons using fruit sourced from Montagu and Franschhoek. Once harvested, the fruit's quality was assessed by looking at flesh firmness and skin colour, the total percentage of soluble solids present in the juice and malic acid levels.

After going through various cold sterilisation and temperature management regimes with and without the addition of SmartFresh™, the plum wrappers were opened and the fruit

stored at 10°C for five days to simulate shelf conditions. Notes were then made of signs of skin shrivel, decay or over-ripeness. Flesh firmness, internal quality (visual signs of gel breakdown or internal browning), taste and skin colour were also considered.

Results and implications

The data confirmed unequivocally that good quality fruit depended on cold-steri treatments being done in combination with SmartFresh™.

Clear differences in how the cultivars reacted to different treatment regimes also came to the fore, along with the realisation that there was more than one treatment option.

"It's critical for the industry to take note of new mitigation treatments. New phytosanitary pests emerge and bring with them the danger of closing down important markets," says Handré.

The trials showed that:

- The quality of 'African Rose' plums was best maintained when SmartFresh™ was applied during the accumulation period, followed by no warming before shipping. This treatment maintained firmness and resulted in the least shrivel and internal disorders, yet allowed the development of good colour. Good results were also seen when SmartFresh™ was applied during the accumulation period, followed by three days of warming at 20°C before shipping.
- After cold-storage, 'Sapphire' plum quality



PROJECT TITLE

Variations of temperature regimes for cold-sterilisation markets

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DURATION

Two years and nine months

PHI PROGRAMME & INDUSTRY CONTRIBUTIONS

R375 375 & R365 375

LEAD INSTITUTIONS

Hortgro Science and ExperiCo (Pty) Ltd

BENEFICIARY

The South African stone fruit industry

FOCUS AREA

Post-harvest disease and insect control, including phytosanitary compliance

PUBLICATIONS

Pending

PRESENTATIONS

One

“It's critical for the industry to take note of new mitigation treatments. New phytosanitary pests emerge and bring with them the danger of closing down important markets.”
Handré Viljoen



1 SmartFresh™ Activation Kit to treat container or room of plums.

2 Assisting André Viljoen (project leader) in one of ExperiCo's laboratories in Stellenbosch are (from left) Elize Parson, Malin Esaus, Mimi Otto, Lorenzo Kerspuy, Kaylinn Samuels, Rene Williams and Nicoleen Andrews. The team do the intake and maturity evaluations of fruit samples, record fruit colour and internal quality, and measure the parameters relevant to the trial.



remained best when SmartFresh™ was applied during the accumulation period, followed by 10 days of warming at 7,5°C before shipping. Flesh firmness was best when SmartFresh™ was applied during the accumulation period, followed by three days of warming at 20°C before shipping. It resulted in fewer signs of internal disorders and only moderate shrivel. Shelf-life quality was best when this regime was used. Quality was also maintained by applying SmartFresh™ during the accumulation period, followed by no warming before shipping.

- 'Fortune' plum quality was best when SmartFresh™ was applied during the accumulation period, followed by three

days of warming at 20°C before shipping. The protocol retained flesh firmness without signs of shrivel and resulted in the least internal disorders. Other treatments using SmartFresh™ were also positive.

- The shelf-life quality of 'Ruby Red' remained best by applying SmartFresh™ during the accumulation period, followed by no warming before shipping. This retained flesh firmness effectively, and resulted in the least number of symptoms of internal disorders and low levels of shrivel. Good results were also seen when fruit was treated with SmartFresh™ during the accumulation period, followed by three days of warming at 20°C before shipping.
- 'Sunkiss' was the only cultivar not showing a clear and confirmed benefit from cold-steri treatment. Further investigations will follow.

A concerning aspect is that a moderate degree of shrivel was seen in some cases when the best treatment options were used. "This can probably be overcome by optimising internal packaging, but further research on, for instance, perforated bags must be done to make sure of this," says André. "I would also like to see more trials that take into account differences in growing conditions and the physiology of the fruit tested."



SMARTFRESH™: MORE THAN A CLEVER IDEA

The SmartFresh™ Quality System is globally recognised as an important tool for fruit quality management.

Launched commercially in 2002, SmartFresh™ is registered and has been approved for use in 46 countries to manage the ripening of climacteric fruit and vegetables by controlling naturally occurring ethylene during storage and transport.

Ethylene triggers ripening and decay in most fruits and vegetables, and can be responsible for storage disorders that spoil products and result in loss and waste. SmartFresh™ reduces fruit waste and maintains the texture, firmness, taste and appearance of fruits by warding off negative ethylene effects.

SmartFresh™ technology's active ingredient is 1-methylcyclopropene (1-MCP), a simple hydrocarbon molecule similar to naturally occurring ethylene. This similarity allows SmartFresh™ to interact with the ethylene receptors in fruit.

SmartFresh™ formulation releases the 1-MCP in the storage room and interacts with the ethylene receptors on the fruit, blocking them temporarily until the fruit comes out of the storage facility or the refrigerated environment. At ambient temperature the fruit develops new ethylene receptors and ripening continues normally.

SmartFresh™ does not leave any residue of 1-MCP (the whole process takes 24 hours).

SmartFresh™ is currently used on:

- Apples
- Kiwifruit
- Pears
- Avocados
- Plums
- Persimmons

SmartFresh™ has an important environmental benefit and allows energy saving. As it limits fruit respiration, less heat is generated in the storage room, which reduces the need for, and cost of, refrigeration and scrubbing.

Benefits for supply chain partners

SmartFresh™ technology increases marketing flexibility, reduces the pressure to sell fruit as soon as possible, and provides more consistent product quality during the entire sales season.

It makes it easier to maintain the quality of ethylenesensitive fruits like plums, persimmons, apples, pears, avocados and kiwifruit.

In export and long-distance transportation scenarios, SmartFresh™ enables fruit to better withstand breaks in the cool chain or unforeseen delays in the supply chain. Additional benefits include compatibility with residue-free programmes and the potential for higher profitability.

Once the fruit has arrived at its destination, SmartFresh™ helps improve shelf life at ambient temperatures.

French retail studies have shown that more than 80% of plums treated with SmartFresh™ technology maintained top quality after seven days, compared to just 48% of control fruits.

Several studies have proven that SmartFresh™ contributes to a slowing down of the decrease of vitamin C throughout the entire apple supply chain and in a number of other crops.

