Helping Cape flora find its sea legs

As the preferred mode of transportation for Cape flora shifts from air to sea, the industry is looking for ways to ensure extended flower quality while simultaneously saving costs.

1 MSc student Stenford Matsikidze and Dr Lynn Hoffman, project leader, observe vase life studies of *Protea* at the Department of Horticulture at Stellenbosch University.
2&3 Conebushes (**2**) (*Leucadendron*) and Pincushions (**3**) (*Leucospermum*) account for about 17% and 14% respectively of all Cape flora products cultivated in South Africa.
4 Signs of chilling injury on *Leucadendron* as a result of long-term cold-storage at sub-optimum temperatures.
5 Kobus van der Merwe, Anel Botes, Prof. Marius Huysamer and Stenford Matsikidze all worked on the Cape flora research project.

IN THE MID-1980s, air transportation of perishable produce became viable for high-value export produce such as flowers and exotic fruits and vegetables destined for niche markets.

In recent years, however, high jet fuel prices, concerns about the carbon footprint of the mode of transport, and advances in sea freight technology, notably the automatic ventilation device (AV+), have stimulated a shift from air back to sea freight.

Most shipping lines use the conventional fixed open air exchange vents system (AirEx) to introduce fresh air while fresh produce – flowers included – is at sea.

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Effective as it is, AirEx is not ideal for Cape flora cut flowers as it was developed for fruit. The air exchange rate is likely higher than what flowers require, resulting in unnecessarily high cold-storage energy costs and an elevated cold-storage drying factor.

Closed ventilation shipping could hold the key to transport that is not only more cost effective, but also better at preserving flower quality. However, the lack of information on the gas exchange dynamics of Cape flora cut flowers stands in the way of the local industry adopting this technology.

According to Dr Lynn Hoffman, lecturer at Stellenbosch University's Department of Horticultural Sciences, new reefer technology cannot be adopted until the ideal rate of fresh air exchange is known. "Suboptimal shipment conditions aggravate the occurrence of leaf blackening and chilling injury," she says. "Hence the carbon dioxide toxicity level and lower oxygen limit for the respective products are vital pieces of information."

THE BENEFITS OF AUTOMATIC VENTILATION DEVICES (AV+)

AV+ intelligently monitors the concentration of O_2 and CO_2 gases inside the container. If concentrations rise beyond the levels that were set for the specific cargo, a valve automatically opens to let in fresh air in order to maintain the optimum atmosphere.

The technology benefits the export industry in three ways:

- **Power saving** – Only the exact amount of air actually needed is allowed to enter the container. The reduction in ambient air exchange results in less air being needed to cool the cargo and less condensation, resulting in a significant reduction in energy use.
- **Temperature control** – Less time spent defrosting translates into more time spent keeping accurate temperature control.
- **Faster pull-down** – By controlling the entry of ambient air rather than allowing a constant high air exchange, pull-down times can be reduced.

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Acting on a request from the Cape flora cut flower industry, which is investigating the adoption of AV+ and dynamic controlled atmosphere (DCA) technology in order to improve long-term cold-storage, Lynn designed a study that received PHI Programme and industry funding in 2014.

The study had three objectives:

1. Determine the level to which CO_2 accumulates and O_2 depletes in a closed ventilation system with a mixed load of Fynbos products.
2. Determine the effect of closed ventilation shipping on the vase life quality of *Protea*, *Leucospermum* and *Leucadendron* cut flowers.
3. Determine the effect of closed ventilation shipping on carbohydrate levels in the leaves of *Protea*, *Leucospermum* and *Leucadendron* cut flowers.

Materials and methods

Various Cape flora cut flower products from different genera of the *Proteaceae* family were used in the study during the 2015/2016 season. The flowers were sourced from Floralae in Paarl, Tussenberge in Napier, Berghoff in Poterville, and Fynbloem in Riviersonderend, in the Western Cape.

The flowers were stored in 610L Janny bins for 21 days at 1°C (±0,5°C) to simulate sea freight conditions. Gas measurements were taken every four days. A hand-held gas analyser was used to monitor the changes in gas levels.

AirEx ventilation rate was the control treatment. Closed ventilation treatment samples were placed in air tight Janny bins with ≈45–55% free air.

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PROJECT TITLE
Defining sea freight transportation conditions for Cape flora cut flower products to align with new reduced energy consumption shipping technology

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DURATION
Two years and four months

PHI PROGRAMME & INDUSTRY CONTRIBUTIONS
R365 874 & R92 517

LEAD INSTITUTIONS
Cape Flora SA and Hortgro Science

BENEFICIARY
The protea and Cape flora industry

FOCUS AREA
Container and cold-storage technology

HUMAN CAPITAL DEVELOPMENT
One MSc student

PUBLICATIONS
Two

PRESENTATIONS
Two

1 Stenford Matsikidze takes gas readings during dynamic controlled atmosphere storage of Cape flora products.
2 Carefully controlled gas dynamics during cold-storage is the key to extended vase life of Cape flora products.

Evaluations were done on 10 replicates per treatment. Analyses included gas concentration, moisture loss, leaf colour, leaf vase life and carbohydrate content.

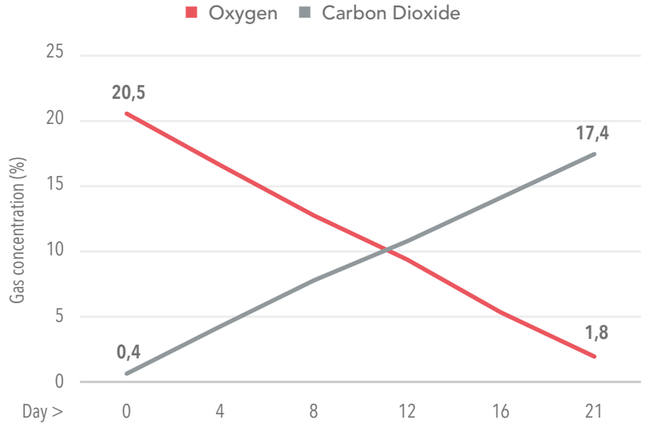
Vase life quality was visually scored on a scale where 4 = export grade, 2,5 = minimum acceptable for retail, and 0 = complete senescence.

Results

Gas dynamics

For *Leucadendron* the O_2 level dropped to ≈1% and the CO_2 rose to ≈20% in a closed ventilation system with ≈45-55% free air (see Fig. 1).

Figure 1: Gas dynamics



Mass loss

Mass loss was higher under the AirEX system than under closed ventilation for both *Leucadendron* and *Leucospermum* products.

Leaf hue angle

- *Leucadendron*: There was significant storage x product x leaf type interaction. Only the hue angle of 'Safari Sunset' involucral and mature leaves differed significantly with storage. However, differences were not visually noticeable and thus did not affect the visual quality score.
- *Leucospermum*: There was no significant difference in leaf hue angle due to storage or treatment.
- *Protea*: Differences in flower head hue angle were due to storage effect. Differences in leaf hue angle were due to product variability. The ventilation system had no significant effect on hue angle.

Leaf vase life quality

- *Leucadendron*: Only the position of the leaves on the stem had a significant influence on vase life quality There were no significant differences in vase life quality of leaves on day one, but there were significant differences in vase life quality on day seven in the 2015 season. However, products had vase life quality that was above the minimum acceptable level for retail. A similar trend was observed in the 2016 season. The *Leucadendron* cultivar 'Discolour', showed the fastest drop in quality after day seven of vase life evaluation.
- *Leucospermum*: There were no significant differences in vase life quality on day one but on day seven the closed ventilation treatment samples had higher quality scores than the control. A similar trend was observed for both 2015 and 2016 season; however, the control treated flowers scored lower than the 2,5 threshold level in the 2016 season.
- *Protea*: There were no significant differences in quality on either day one or day seven of vase life evaluation.

Carbohydrate content

- *Leucadendron*: There were no significant differences due to any factor in the 2015 season. 2016 results showed that carbohydrate content was significantly influenced by both product type and carbohydrate type interaction, and also carbohydrate type and treatment interaction. Monosaccharides and oligosaccharides were higher in AirEX treated samples and polysaccharides and starch were higher in closed ventilation treated samples.
- *Leucospermum*: Monomers and oligosaccharides were higher in control samples compared to those in closed ventilation samples.
- *Protea*: There was significant product x treatment interaction with some products showing higher monosaccharide and oligosaccharide levels under control treatment and vice versa, while other products exhibited no significant differences.

There were no signs of CO_2 toxicity or low O_2 stress in the gas dynamics tests.

Despite having lower monomer and oligosaccharide levels, the closed ventilation samples had higher polysaccharide and starch content. The latter suggests the potential for better vase life quality.

More trials need to be done to confirm this study's results, investigate seasonal effect, test commercial feasibility and investigate the possible use of controlled atmosphere technology to reduce *Botrytis* infections. These will be concluded in April 2017 and final results will be published on the PHI Programme website.

However, the study's findings have confirmed that closed ventilation shipping is a promising technology that warrants further research on more Cape flora products. It has the potential to reduce cold-storage energy costs and the carbon footprint associated with the exporting of Cape flora cut flowers, while improving their vase life quality.

Conclusions

Closed ventilation shipping of *Proteaceae* cut flowers resulted in lower moisture loss during storage and better flower head vase life than that after controlled ventilation shipping.

3 Cape flora products are graded and packed according to industry standards to ensure only top quality flowers are exported.
4 Immediately after cut flower stems have been packed, they are placed in the pre-cooling unit to remove field heat. The flowers are kept in the cold room until a refrigerated truck transports the cargo to the airport or the Port of Cape Town.