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Special Research Report #452: Innovative Packaging Technologies to Enhance the Quality of Fresh Cut Flowers

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BACKGROUND

Improvements in the distribution and packaging of fresh cut flowers have the potential to provide technological innovation that can benefit everyone at any point in the postproduction chain. The objective of this project was to develop a science-based packaging system using the following technologies to maintain the quality of fresh cut flowers: (1) 1-methylcyclopropene (MCP) to delay or inhibit ethylene mediated flower senescence, (2) natural anti-microbials from thyme (*Thymus vulgaris*) an essential oil to minimize microbial damage to flowers and potted plants, and (3) modified atmosphere packaging technology. Each system is designed to optimize the flowers' postproduction environment and, thus, extend shelf life. These objectives address important economic needs in the market to extend and maximize the shelf life of high value and highly perishable crops.

Ethylene induced abscission occurs at very low concentrations and may result in the premature loss of plant flowers and leaves. *Botrytis cinerea*, the causal agent of "gray mold disease", is a problem during the preharvest and postharvest periods. However the major effects on cut flowers often occur during the postharvest stage. A floral commodity, whose quality is ephemeral and purely aesthetic, not only presents some unique challenges but also suffers from very similar problems as edible produce. We have focused on roses and snapdragons. These are important cut flower commodities and are sensitive to ethylene and fungal diseases.

The use of natural anti-microbial compounds and the replacement of more toxic ethylene antagonists with MCP in an integrated package form could help to make the cut flower industry more competitive. In addition, the industry can position itself to take advantage of consumer interest in eco-friendly production. MCP sachets and modified atmosphere packaging (MAP) are established postharvest technologies; however, the use of thyme oil anti-microbials is experimental. There are two methods to deliver the anti-microbials: (1) incorporation into the polymer packaging film or (2) encapsulation in cyclodextrin (CD) for release from a sachet. Delivery of the anti-microbial from a sachet is the primary subject of this report.

MATERIALS & METHODS

Isolates of *Botrytis cinerea* were collected from roses and strawberries. The cultures were maintained on PDA in the dark at 25 ˚C and sub-cultured biweekly. Suspensions of *B. cinerea* conidia (10^4/mL) were washed from 14-day-old potato dextrose agar (PDA) cultures and used to inoculate fresh cut snapdragons and roses. Rocket series snapdragons were grown in a greenhouse and roses were purchased from a local market. Thyme oil (TO) was encapsulated into CD and placed into sachets made of Tyvek™. MCP sachets (Ethylbloc™) were donated by Floralife. PeakFresh modified atmosphere packaging (MAP) was used.

Roses were inoculated with *B. cinerea* spores. 4 cm x 4cm Tyvek™ sachets were filled with thyme oil (TO): β-cyclodextrin (CD) capsules prepared from a ratio of 14:86 TO: CD and heat sealed. Alternatively, Tyvek™ sachets were filled with CD alone (control) and heat sealed. Two sachets were adhered to MAP sleeves (PEAK*fresh*USA) and 4 to 6 rose flowers were placed into the sleeves. The flowers had previously been placed into a commercial hydration solution (Chrysal Clear Professional 1, Chrysal International B.V., Narden, Netherlands) with 0.2 micromoles Silver Thio Sulfate (mM STS). One petal of each rose was inoculated with 5 μL of *Botrytis cinerea* conidial spore suspension (2500 spores). The stems of the sleeved roses were placed in 2 L flasks containing commercial processing solution (Chrysal Clear Professional 2) and held at 5 °C for 3 days. The flowers were then removed from the sleeves transferred to 25 °C and the stems were cut and placed in commercial vase solution (Chrysal Clear Professional 3). Each treatment had two replicates.

RESULTS

The results are shown in Figure 1. Roses treated with TO: CD sachets had a markedly lower incidence of disease and longer vase life.

Six to eight snapdragon stems were placed in a bunch and wrapped in MAP sleeves (PEAK*fresh*USA) fitted with 3 sachets either made of a ratio of 14:86 TO:CD or CD alone, and then placed in a commercial hydration solution (Chrysal Clear Professional 1) for 16 hours at 5 °C in the dark as shown in Figure 2. Prior to storage, a flower on each stem was inoculated with 5 μL of *Botrytis cinerea* conidial spore suspension (2500 spores). After 16 hours the snapdragons were transferred to cardboard shipping boxes fitted with either two Ethylbloc™ sachets or without the Ethylbloc™ sachets as shown in Figure 2.

The snapdragons were simulated-shipped in the dark at 5 °C for 4 days. Then, the snapdragons were removed from the boxes, the Ethylbloc™ sachets discarded, and the snapdragon stems placed in vases containing commercial processing solution (Chrysal Clear Professional 2) and held at 5 °C for 1 day. The flowers were then removed from the sleeves, transferred to 25 °C, and the stems cut and placed in commercial vase solution (Chrysal Clear Professional 3). The flowers were evaluated and the results are shown in Figure 3.

A

B

Fig. 1. A. Vase on left treated with CD and vase on right treated with TO. Vase life 12 d. Arrows indicate Botrytis lesions. B. Vase on left treated with TO and vase on right treated with CD. Vase life is 6 d. Arrow indicates Botrytis lesions.

Fig 2. Clockwise from left: Chrysal solutions, TO sachets, Ethylbloc sachets, flowers in Chrysal 1 solution enclosed in MAP sleeve with TO sachet (arrow), and flower bouquet in shipping box with Ethylbloc sachet (arrow).

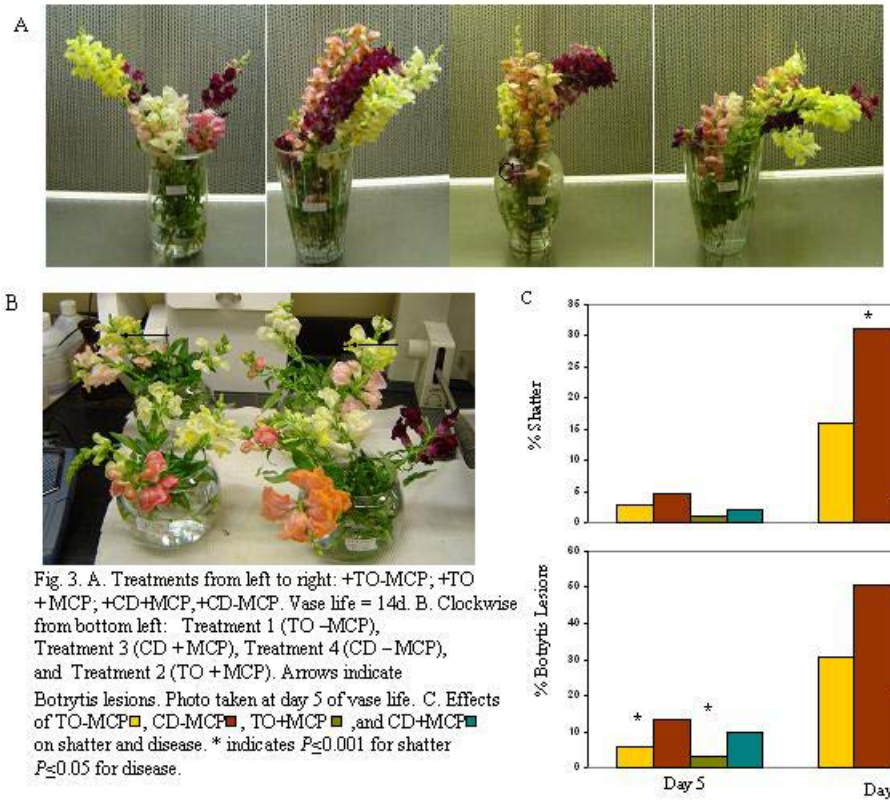

Fig. 3. A. Treatments from left to right: +TO-MCP; +TO +MCP; +CD+MCP,+CD-MCP. Vase life = 14d. B. Clockwise from bottom left: Treatment 1 (TO –MCP), Treatment 3 (CD +MCP), Treatment 4 (CD – MCP), and Treatment 2 (TO +MCP). Arrows indicate Botrytis lesions. Photo taken at day 5 of vase life. C. Effects of TO-MCP, CD-MCP, TO+MCP ,and CD+MCP on shatter and disease. * indicates $P \leq 0.001$ for shatter $P \leq 0.05$ for disease.

Flowers treated with TO+MCP had the lowest level of disease both at 5 days and 14 days vase life (sage green bars). Flowers treated with Ethylbloc™ had the least shatter compared to ones without MCP (sage green and blue bars vs. yellow and red-brown bars). Although not statistically significant in this experiment, TO seemed to reduce shatter in snapdragons by day 14 of vase life (yellow bar vs. red-brown bar).

CONCLUSIONS

The combination of MAP, Ethylbloc™, and TO: CD sachets extended the shelf life of fresh cut snapdragons by reducing shatter and disease. MAP appears to prevent dehydration of the snapdragons (data not shown). Roses were not treated with Ethylbloc™ since they had already been exposed to STS. The TO: CD sachets reduced the level of Botrytis infection. Thus, it appears that there are compounds in TO that have an anti-ethylene effect.

INDUSTRY IMPACT

Petal shatter induced by ethylene and/or infection by *Botrytis cinerea* reduces the shelf life of fresh cut flowers. This project demonstrates the potential for using a combination

of MAP, 1-MCP, and TO: CD sachets to optimize storage conditions for fresh cut flowers such as roses and snapdragons. The addition of TO: CD sachets to the existing postharvest technologies, to reduce disease appears very promising. Increased postharvest longevity could improve shipping and storage options for flowers, which should lower shipping costs without decreasing viability and quality.

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