



# RESEARCH REPORT

## New packaging technology may provide boost to vegetable growers, shippers

Colleges of  
Agriculture at

*J. Wyatt Brown, Horticulture and Crop Science Department  
California Polytechnic State University, San Luis Obispo*

### Introduction

The use of Modified Atmosphere Packaging (MAP) technology is advancing from infancy to its adolescent stages. As the technology matures, new applications that make the technology adaptable and user-friendly will require validation. One such novel application for MAP is the SLX container system produced by SLX International, a San Luis Obispo-based corporation. The container is made of food-grade plastic with a hermetic seal able to contain a modified inner atmosphere (Fig. 1). The container is re-usable and is considered a “green technology,” as opposed to paperboard containers that are single use and disposable. It is the intent of the investigators to use the SLX container for the optimization of shelf-life and shipping quality of California-grown perishable agricultural commodities. Primarily, fruits and vegetables applicable to MAP transport were studied. Research parameters include, but are not limited to, respiration rate of the commodity, color, taste, odor, and microbial

load of the commodity, as well as extension of quality factors over time and distance shipped. Optimization of these parameters for various produce commodities will allow for extended market access of



Figure 1. Modified SLX containers showing sealed MAP film patches at forward and rear locations.

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such shipped items. As regional markets are saturated, growers, packers, and shippers must seek distant markets. In addition, with the advent and expansion of the global marketplace, more and more people desire fresh, high-quality produce items, from California too, if they can get them. The main objective of the proposed study was to investigate and define the criteria and parameters necessary for optimization of quality, thus allowing for extended shipment of California agricultural commodities. This will allow for sale of fresh items all around the globe, especially to lucrative, previously inaccessible markets in Asia and Europe.

## Executive Summary

The SLX International Inc. container was tested for its ability to facilitate the long-term storage of broccoli florets (Fig. 2). Containers were modified to develop and maintain optimal Modified Atmosphere (MA) conditions (2-5 percent O<sup>2</sup> and 15-20 percent CO<sup>2</sup>). Modification and/or preparation of the containers included 1) vacuum purging of O<sup>2</sup>, followed by replacement with N<sup>2</sup>; 2) vacuum purging of O<sup>2</sup>, followed by replacement with N<sup>2</sup> and CO<sup>2</sup>; 3) injection-valve replacement with low gas-transmission rate (GTR) films; 4) injection-valve replacement with high GTR films; 5) inclusion of one or two 63.5mm-wide container-lid holes covered with low or high GTR films; 6) inclusion of one or two 63.5mm-wide container sidewall holes covered with non-perforated high GTR film; 7) inclusion of two 63.5mm-wide container sidewall holes covered with custom-perforated (macropore) film (Fig. 1). After each preparation, containers were packed with 18.14 kg (40 lbs) broccoli florets and placed in refrigerated storage. Depending on the experiment, containers were held for 14 days at 1.1°C or 3.33°C and ambient or 80 percent RH, followed by storage at 7.2°C. This regimen was intended to simulate temperatures



**Figure 2. Broccoli floret appearance after 28 days storage (14 days at 2.22 ± 0.5°C, followed by 14 days at 7.22 ± 0.5°C) in the SLX-MAP II.**

during international shipment followed by those incurred during marketing (early results indicated that RH had negligible effect when the produce was held in the SLX container and, therefore, RH was not controlled for most experiments). In-package atmosphere within containers was monitored over the duration of each study.

All container modifications failed to maintain aerobic conditions within the containers for a period longer than 14 days, with the exception of the containers modified to have two sidewall holes covered with custom-perforated film and stored at 3.33°C. Therefore, only the florets stored using this method were sampled. Color and firmness were measured after 21, 28 and 42 days storage. Firmness was unaffected by MA treatment. The greenness of florets stored in the modified SLX containers was slightly less than that of florets stored in a commercial plastic bag. The lackluster performance of the modified SLX container was determined to be due to leakage of the containers at the box-lid seal point. After correcting the leakage problem, florets were again stored in containers modified to have two sidewall 63.5mm ports covered with custom-perforated film. Florets were sample only for color after 28 days continuous

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storage at 1.1°C. Results from this experiment indicated no significant difference in floret color or in-package atmosphere after 28 days storage compared to the control. However, observations made with regard to overall microbial load indicated that use of the SLX container appeared to significantly reduce bacterial growth on the florets (Fig. 2). Further investigation will need to be performed to verify this observation.

## Major Accomplishments

The research to date has primarily concentrated on development of an MA method for exporting broccoli florets, which will produce the desired gas atmosphere within SLX containers. The research at Cal Poly was successful and included the following results:

- ◆ Work performed indicated that two sidewall ports with macro-perforated film patches would yield the desired container modified atmosphere for broccoli florets. Based on this work, SLX International Inc. developed exchangeable film cartridges which would attach to the containers at the side ports. These cartridges will contain different MA film “patches” depending on the commodity to be shipped. The work to determine the correct perforation number and/or pattern on the patches has yet to be performed. However, it appears that SLX will apply for a patent or patents for these cartridges stemming from this research.
- ◆ Work performed indicated that SLX International had significant manufacturing problems with the gaskets used in the lids to seal the containers. SLX International has since indicated that this problem has been rectified.
- ◆ Research indicated that SLX containers, when used to produce a modified atmosphere suitable for broccoli florets, might act to significantly reduce the microbial load on the florets, thus reducing health risks as well as extending shelf life. Research to verify these initial observations has yet to be performed.

## Impact Statements

- ◆ A successful MA system for export-quality broccoli florets has been developed based on cartridge-contained, macro-perforated film patches.
  - ◆ This MA system will lend itself to a number of products, though the research to optimize the system for other commodities has yet to be performed.
  - ◆ The research that has been performed has increased SLX International's position to economically benefit from the sale of its containers, and a patent or patents based on this technology appear to have been applied for.
  - ◆ The research performed under the ARI suggests that a prime benefit of using the SLX container is decreased development of rot and slime during long-term storage of broccoli. If corroborated, this should greatly increase SLX International's ability to sell its product.
  - ◆ This container/MA system fills a niche in marketing for an RPC, or re-usable plastic container.
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## Dissemination

- ◆ Kevin Healy, graduate student, Cal Poly, SLO/Ed deTemple, SLX International – Presentation of SLX container and preliminary results of research at United Fresh Fruit and Marketing Association meeting, 2001.
- ◆ Ed and Tom deTemple, SLX International – Presentation of SLX container and preliminary results of research at United Fresh Fruit and Marketing Association meeting, 2002.
- ◆ Ed and Tom deTemple – Presentation of SLX container and preliminary results of research at Produce Marketing Association meeting, 2001, 2002.
- ◆ Ed and Tom deTemple – Presentation of SLX container and preliminary results of research at Fresh-cut Produce Association's annual meeting and exposition, 2001, 2002.
- ◆ Ed and Tom deTemple – Presentation of SLX container and preliminary results of research at Food Technologists annual Food Expo, 2001, 2002.
- ◆ Kevin Healy/J. Wyatt Brown – Presentation of research results with broccoli to Gold Coast Packing, February, 2002.
- ◆ J. Wyatt Brown/Brian C. Hampson – Discussion of research and results with delegation of Chinese businessmen and women, May, 2002.
- ◆ J. Wyatt Brown – Posting of research summary at Crop Science Program website, January, 2003.

### Principal Investigator

#### J. Wyatt Brown, Professor

Horticulture and Crop Science Department  
California Polytechnic State University,  
San Luis Obispo  
Phone: 805-756-6137  
Email: wbrown@calpoly.edu

#### Brian C. Hampson, Professor

Department of Food Science and Nutrition  
California Polytechnic State University,  
San Luis Obispo  
Phone: 805-756-6127  
Email: bhampson@calpoly.edu

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## For More Information

This research report contains summarized results of J. Wyatt Brown's study entitled "Bulk Modified Atmosphere Packaging of Fresh Produce Commodities," ARI Project No. 02-3-017 (Research Focus Area: *Food Science*). To view and/or obtain a copy of the complete final report, or to obtain additional information about this or other research projects, visit the ARI website at [ari.calstate.edu](http://ari.calstate.edu). For information on projects specific to Cal Poly San Luis Obispo, visit the Cal Poly ARI website at [ari.calpoly.edu](http://ari.calpoly.edu).

### ARI Administration

California Agricultural Technology Institute  
California State University, Fresno  
2910 E. Barstow Ave. M/S OF115  
Fresno, CA 93740-8009  
Phone: (559) 278-2361  
Fax: (559) 278-4849  
ARI Website: [ari.calstate.edu](http://ari.calstate.edu)

### ARI Executive Director

Joe Bezerra, Director of Operations  
California Agricultural Technology Institute  
California State University, Fresno

The Agricultural Research Initiative (ARI) is a California State University (CSU) multiple campus collaborative partnership between the CSU colleges of agriculture and the state's agriculture and natural resources industries and allied business communities. ARI provides public funds that are matched with industry resources to fund high impact applied agricultural and natural resources research, development, and technology transfer, as well as related public and industry education and outreach. ARI projects and programs improve the economic efficiency, productivity, profitability, and sustainability of California agriculture while providing for consumer sensitive and environmentally sound food and agriculture systems and fostering public confidence in food safety and agricultural research and production systems.