

## Strawberry Test with Bluezone® Technology for Mold Control/Fresh Preservation:

### Summary:

Strawberries stored for 10 Days under Bluezone® Control exhibited less mold, less ripening, and less undesirable odor than strawberries from the same original pallet stored in an identical refrigerated chamber without the Bluezone® Unit.



Strawberry View from Webcam

PK-1 No Bluezone® – Day 10

(Berries 20 days old, total)

Mold growth on multiple berries.



Strawberry View from Webcam

PK-2 With Bluezone® – Day 10

Berries 20 days old, total

No Visible Mold

## Starting Strawberry Quality and Duration of Testing

Tests were conducted with two pallets of California, Driscoll strawberries, packed with 1 pound, vented, plastic clamshells, 8 clamshells to a cardboard flat, six flats per layer, 40" X 48" wood pallet base, total of 18 layers of strawberries per pallet. These two pallets were a minimum of 10 days old when we initiated the test. (The previous 10 days included five days in transport from California to Chelsea AM in Tectrol Pallet Cover, followed by 5 days of storage at the distribution center in Chelsea MA). The two pallets and all flats in each pallet were labeled as Pallet A and Pallet B. On receipt, Pallet B already showed significant signs of mold and decay. Berries in Pallet A exhibited far less mold from the start.

Flats from Pallet A were marked and a total of 18 flats were identified, numbered, and photographed for detailed analysis at the end of the test. Each refrigerated container was filled with 9 marked, numbered, and photographed flats from Pallet A along with all the other flats from both Pallet A and B. Flats from Pallet B were distributed evenly between the two refrigerated containers, but were not used in subsequent evaluations because they were already exhibiting mold growth.

Photographs of typical flats from Pallet A and B are shown below.



Typical Flat from Pallet A



Typical Flat from Pallet B

Pallet B was clearly older or had more decay than the other.

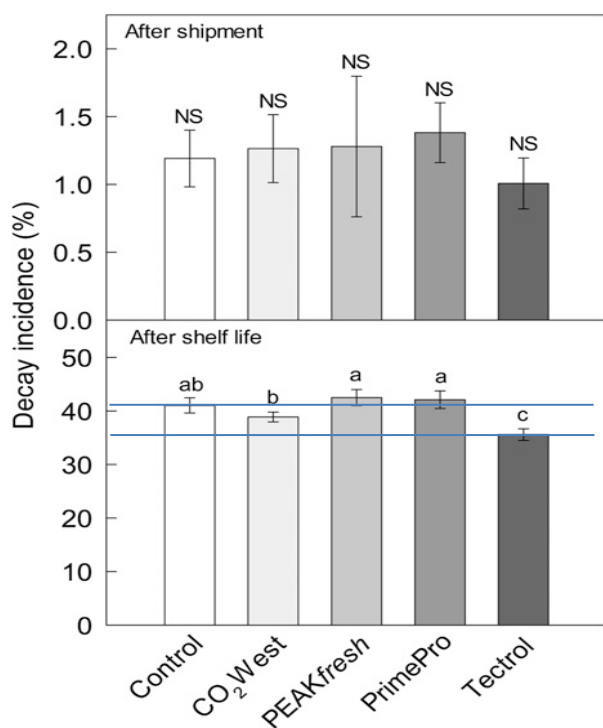
## Background on Methods and Alternative Preservation Systems

### *Source of Method*

Sampling and measurement methods were adapted from strawberry test methods documented in a paper written by researchers at UC Davis Department of Plant Sciences and University of Florida Horticultural Sciences Department. *Comparison of Pallet Cover Systems to Maintain Strawberry Fruit Quality During Transport* by Andrew Macnish, Malkeet Padda, Francine Pupin, Pavlos Tsouvaltzis, Angelos Deltisidis, Charles Sims, Jeffrey Brecht, and Elizabeth Mitcham, **Hortechology**, 22(4) August 2012 describes test methods and evaluation methods in detail. The paper defined the value of testing after removal from the refrigerated container and after two days at room temperature storage.

### *Standard of Comparison for Bluezone® Technology for Strawberry Preservation*

MacNish describes the value of strawberry pallet cover systems that create a high CO<sub>2</sub> concentration environment in order to reduce mold growth/decay. There was not significant impact of these systems on maintenance of fruit firmness and weight loss. Impact of the CO<sub>2</sub> systems on decay incidence is shown below. After 2 – 4 days in refrigerated transport, there was insignificant impact of any of the CO<sub>2</sub> pallet cover technologies. After 2 additional days at room temperature (shelf life), however, the Tectrol system reduced the incidence of decay from over 40% to approximately 36%. This controlled atmosphere method is considered state of the art for fresh preservation of berries.



Improvement from CO<sub>2</sub> Controlled Atmosphere is about 10% reduction in Decay incidence, from 41% to 36%.

## Strawberry Test: April 16 to April 26

(Strawberry age 10 days to 26 days)

### Loading: April 16, 2013



Two Polar King Containers with sampling lines



2 Pallets of Driscoll Strawberries Delivered



Loading cartons into Polar Kings





Partially filled Polar King.



Loaded PK. Bluezone® Unit in front Right.

### Measurements:

- Photographs via webcam taken twice daily of 8 clamshell containers in one flat of berries at top of pallet in each refrigerated container.
- Counts of mold and evaluation of ripeness from 6 flats of strawberries (identified at the start of the test) from each refrigerated container removed from each container on Day 10 of the test.
- Penetrometer tests of fruit pressure taken from randomized containers from the 3 flats of strawberries (identified at the start of the test) from each refrigerated container removed on Day 7.
- Continuous measurement of temperature and humidity in each container for the duration of the test.
- Measurements of CO<sub>2</sub>, ozone and VOCs in each container at multiple points in the test duration
- Surface microbial sampling from randomized berries from each container at the start of the test
- Surface microbial swabs from the container walls at the start and end of the test

**Results: Photographs of Flat Viewed by Webcam 2 X per day for 10 days.**



PK-1 (No Bluezone) Day 1



PK- 1 (No Bluezone) Day 10



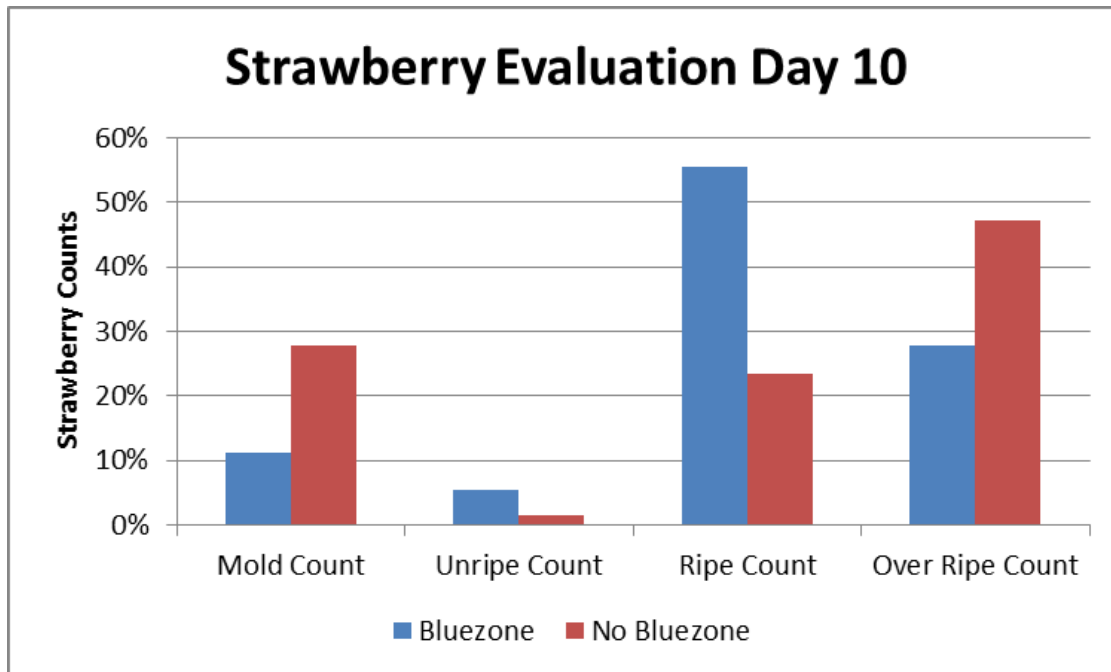


PK-2 (Bluezone) Day 1



PK – 2 Bluezone Day 10

Six strawberry flats from each container (identified on Day 1 for evaluation) were removed from both refrigerated containers. Two flats from each set were set aside for evaluation after a day at room temperature. Each strawberry in each clamshell of each flat (four flats from each container) was examined for mold and ripeness, using the scale shown below. The results showed significant benefit of the Bluezone unit for both mold reduction and control of ripening.



Strawberry counts after removal from refrigerated storage, Day 10 (20 days total berry life)



LIGHT/NOT  
RIPE



PERFECTLY  
RIPE (FIRM)



OVER RIPE/  
ROTTEN

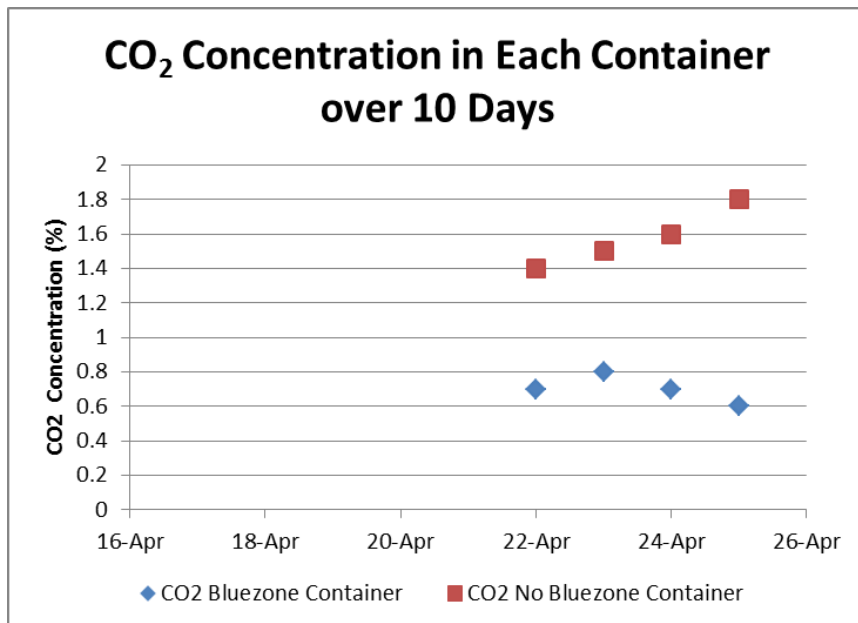
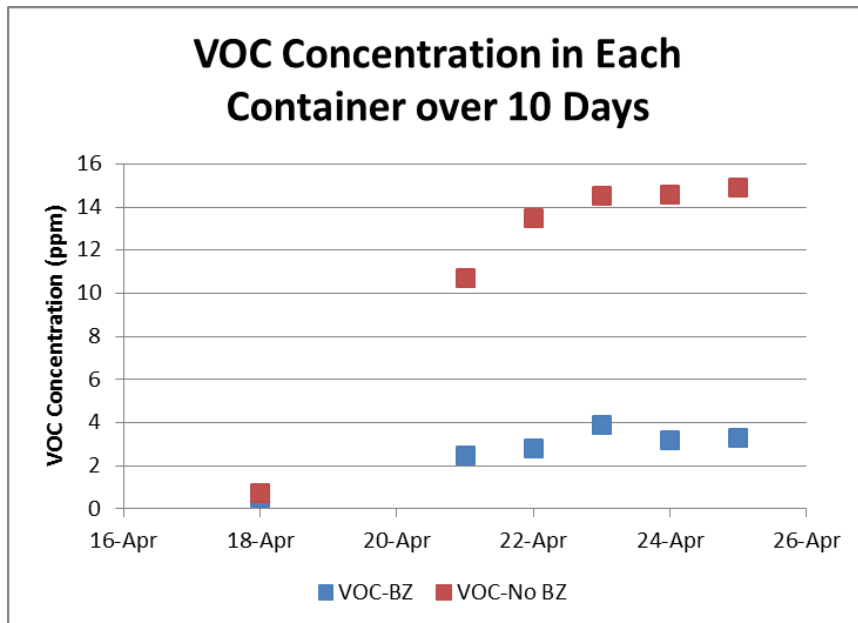


Mold



## Gas Measurements/Odor

Over by the 5th day of the tests, Volatile Organic Compound concentration in the container with the Bluezone® unit were held to than 25% of the VOC levels in the container without the Bluezone® unit. Carbon dioxide levels in the Bluezone container were roughly half that of the other container. By Day 5 in the tests, a strong odor of alcohol/aldehydes were emanating from the container without the Bluezone® Unit. When the strawberries were removed from the container on Day 10, the odor in the non-Bluezone® container was quite foul, while the smell in the Bluezone container was less intense and consistent with “strawberry” odor.



### **Typical Temperature and Humidity Data from Both Containers**

Temperature and humidity levels in each container were continuously logged. Each container held the temperature to 34 – 36 °F. Relative humidity cycled between 85 - 92% in each container.