Extending Shelf Life and Preserving Quality in Fresh Fruit & Vegetable Storage and Transport

Product Performance and Market Benefits
Primaira’s Bluezone® technology preserves fresh fruit and vegetable (FF&V) quality and extends shelf life.

- Applications along the entire global supply chain:
  - FF&V packing, storage, distribution, transport, retail sale and consumer use.
- Primaira’s Bluezone® technology removes the decay-producing chemical and microbial agents from the air
  - Without introducing any chemicals or gases to the FF&V storage space.
- An analysis of the cost of FF&V loss and the price of the Bluezone® products demonstrates that the Bluezone® will pay for itself in the first few months of service:
  - Customer profits from an extraordinary rate of return and reduction of risk.
Primaira’s Bluezone® technology preserves fresh fruit and vegetable quality and extends shelf life along the global refrigerated supply chain.

- Unique, patented technology strips ethylene, microbes, hydrocarbons and odors from the air in refrigerated containers.
- Developed and demonstrated for the US Army for maximum ethylene removal for mixed load applications.
  - Rugged, cost effective, safe,
- Extends shelf life of sensitive perishables up to 2 weeks.
- Demonstration tests in side-by-side, 20’ reefers
  - Saved $1600 in produce losses per 20’ load
- Can be applied to a container of any size
  - Coolers, Walk-ins, Reefers (20’, 40’)
- Allows flexibility in packing for lower cost and higher quality
  - Optimize container temperature
  - Combine ethylene sensitive and ethylene producing produce
The US Army funded the development of the Bluezone® Fresh Preservation Technology to deliver the highest quality fruits and vegetables for our troops.

- Army-tested
- Military approved
- Award-winning
- Commercially available
**Technology:** Primaira, LLC has developed and is testing a safe, low cost, low maintenance, plug-and-play solution to ethylene and microbial control.

- Bluezone® Reaction Technology for refrigerated containers and coolers
  - Removes ethylene from ambient air for shelf life extension
  - Kills airborne molds, fungus and bacteria
  - Eliminates odors and flavor transfer
  - Consumes only 100 - 250W (depending on container size) and occupies about 1% of container volume

- The technology to implement the science is novel, cost effective, and patented.
- System is easy to install and remove
Fresh fruit and vegetable storage enhancement is achieved by removing ethylene from the refrigerated space.

- Small amounts of ethylene can induce fruit ripening, produce undesirable changes to flavors (bitterness), color (yellowing or browning), and texture (softening), and increase susceptibility to disease.
- The amount of ethylene that produces undesired characteristics varies with individual fruits and vegetables, but ethylene concentrations in the range of 1-10 ppm can produce a significant effect.
- Certain fruits and vegetables generate ethylene as a natural part of their ripening cycle.
- Other fruits and vegetables are highly sensitive to the presence of ethylene, but may or may not produce the ethylene themselves.

Confidential Information
We tested the Bluezone Model 1200 Unit for ethylene pull-down performance at 10 and 20ppm starting concentration, and also with Unit OFF (container leakage).
Additional testing shows that pull down rate is not affected by CO$_2$ concentration, temperature or humidity.
The Bluezone® unit kills airborne microbes.
The Bluezone® unit kills airborne microbes.

11/22/11 - Before Bluezone Model 300 Installation

11/30/11 – Bluezone Model 300 in Operation
Bluezone® Model 1200 units in commercial shipment

Fully operational unit installed in Force Provider TRICON to support in-field testing
Technology Comparison: Bluezone® technology is far superior to its competitors in ethylene removal and microbial reduction.
Test: A mixed load, Fresh Fruit and Vegetable (FF&V) storage test was conducted with and without the Bluezone® technology to remove ethylene and airborne microbes.

• Test Objective:
  – To quantify the effectiveness of the Bluezone® technology in improving quality and extending the storage life of fresh produce.

• Test Configuration
  – Two, 8’X8’X20’ Refrigerated Containers, each set to 34°F with ventilation sufficient to maintain CO₂ below 1%.
  – Mixed produce load of ethylene sensitive and ethylene producing FF&V.
  – Temperature, humidity, carbon dioxide and ethylene measurements taken at regular intervals.
  – One container with Bluezone®, One container without Bluezone™
  – Test Duration
    • 21 Days of Refrigerated Storage
    • 5-10 Additional days of ambient temp storage for specified FF&V
**Demonstrated Results:** The facilities and staff at REI in LA assured that produce was maintained at storage conditions during loading, unloading, and inspection.

Coolers were loaded and unloaded rapidly.  
Coolers held produce for end of test inspection.
Ethylene concentrations in the Bluezone® container were maintained at 0.6 ppm throughout the test, while uncontrolled ethylene rose to about 10 ppm.
A Bluezone® Unit is highly cost effective in reducing produce losses.

<table>
<thead>
<tr>
<th>Produce Type</th>
<th>Damage Prevented with Bluezone®</th>
<th>Cost Savings from Reduced Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaches</td>
<td>Reduced ripening and decay</td>
<td>$288</td>
</tr>
<tr>
<td>Asparagus</td>
<td>Reduced rot and stalk damage</td>
<td>$75</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Reduced browning and loss of integrity</td>
<td>$230</td>
</tr>
<tr>
<td>Oranges</td>
<td>Reduced mold</td>
<td>$37</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Reduced spotting and rot</td>
<td>$200</td>
</tr>
<tr>
<td>Melons</td>
<td>Reduced rot and mold</td>
<td>$132</td>
</tr>
<tr>
<td>Garlic</td>
<td>Reduced cracking, mold, sprouting</td>
<td>$140</td>
</tr>
<tr>
<td>Carrots</td>
<td>Reduced bitterness</td>
<td>$500</td>
</tr>
<tr>
<td><strong>Total Savings in 20’ Reefer shipment</strong></td>
<td><strong>$1602</strong></td>
<td></td>
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</table>
Asparagus Damage is Significantly Reduced with Bluezone®.

Asparagus Damage After 21 Days Storage

<table>
<thead>
<tr>
<th>Condition</th>
<th>Bluezone™</th>
<th>NO- Bluezone™</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Red Tip</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>% Tip Rot</td>
<td>75</td>
<td>40</td>
</tr>
<tr>
<td>% Curved Spear</td>
<td>25</td>
<td>38</td>
</tr>
<tr>
<td>% Stalk Damage/Shrinkage</td>
<td>10</td>
<td>38</td>
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</tbody>
</table>
Bluezone® Reduces Ripening in Peaches.

Peach Firmness Change After 21 Days

- Cheek Start
- Cheek End No
- Bluezone™

Replication A  Replication B  Replication C
Cauliflower experienced total, catastrophic loss of leaves over the 21 day test **without** the use of the Bluezone®.

Bluezone™

No
Bluezone™
Use of the Bluezone® significantly reduced russet spotting in Wrapped Iceberg Lettuce over the 21 day storage period.

Percentage of Lettuce Heads with Russet Spotting

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Percentage of Lettuce with Russet Spotting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BZ: 70% No BZ: 70%</td>
</tr>
<tr>
<td>2</td>
<td>BZ: 30% No BZ: 90%</td>
</tr>
<tr>
<td>3</td>
<td>BZ: 50% No BZ: 70%</td>
</tr>
<tr>
<td>4</td>
<td>BZ: 10% No BZ: 50%</td>
</tr>
<tr>
<td>5</td>
<td>BZ: 30% No BZ: 80%</td>
</tr>
</tbody>
</table>
The Bluezone® reduced the incidence and extent of surface mold and decay on the cantaloupe melons.
Bluezone® use demonstrated significant reduction of cracking, sprouting and mold in Garlic.

![Garlic Characterization after 3 Weeks Storage](image)
Development was sponsored by the DOD Combat Feeding Directorate to improve quality of FF&V to troops.