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Extending Shelf Life and Preserving Quality in FF&V Shipping and Storage

Demonstration Test Results

Bluezone preserves fresh fruit and vegetable quality and extends shelf life along the global refrigerated supply chain.

- **Unique, patent pending technology strips microbes, ethylene, hydrocarbons and odors from the air in refrigerated containers and cold storage spaces.**
- **Developed and demonstrated for the US Army.**
  - Rugged, cost effective, safe,
- **Extends shelf life of sensitive perishables up to 2 weeks.**
- **100% Return on investment in two shipments; annual ROI of 500%.**
- **Demonstration tests in side-by-side, 20' reefers**
- **Long term operation experience in walk-in cooler**
- **Three product sizes:**
  - Model 300 (Tricon containers)
  - Model 1200 (20' reefers)
  - Model RI 20 (Reach-in refrigeration)

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The Bluezone® system, with 10 year life and 1 year maintenance intervals pays for itself in two, 3-week, FF&V, 20' reefer shipments.

Produce Type	Damage Prevented with Bluezone	Cost Savings from Reduced Loss
Peaches	Reduced ripening and decay	$288
Asparagus	Reduced rot and stalk damage	$75
Cauliflower	Reduced browning and loss of integrity	$230
Oranges	Reduced mold	$37
Lettuce	Reduced spotting and rot	$200
Melons	Reduced rot and mold	$132
Garlic	Reduced cracking, mold, sprouting	$140
Carrots	Reduced bitterness	$500
	Total Savings in 20' Reefer shipment	**$1602**

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Background: 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.

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Technology: Bluezonehas developed and is testing a safe, low cost, low maintenance, plug-and-play solution to ethylene control.

- **Bluezone® for refrigerated storage:**
  - **Removes ethylene from ambient air**
  - **Consumes only 100 - 250W (depending on container size) and occupies about 1% of container volume**
  - **Kills airborne molds, fungus and bacteria**
- **The technology to implement the science is novel, cost effective, and protected (patent pending).**
- **System is easy to install (four mounting bolts)**
- **Service interval is greater than one year**
- **Applicable to transport containers, walk-in refrigeration, or warehouse storage.**

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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 CO_2 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

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The facilities and staff at REI in Los Angeles CA 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

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The Bluezone® Unit was installed in the back, top, right corner of Container 1.

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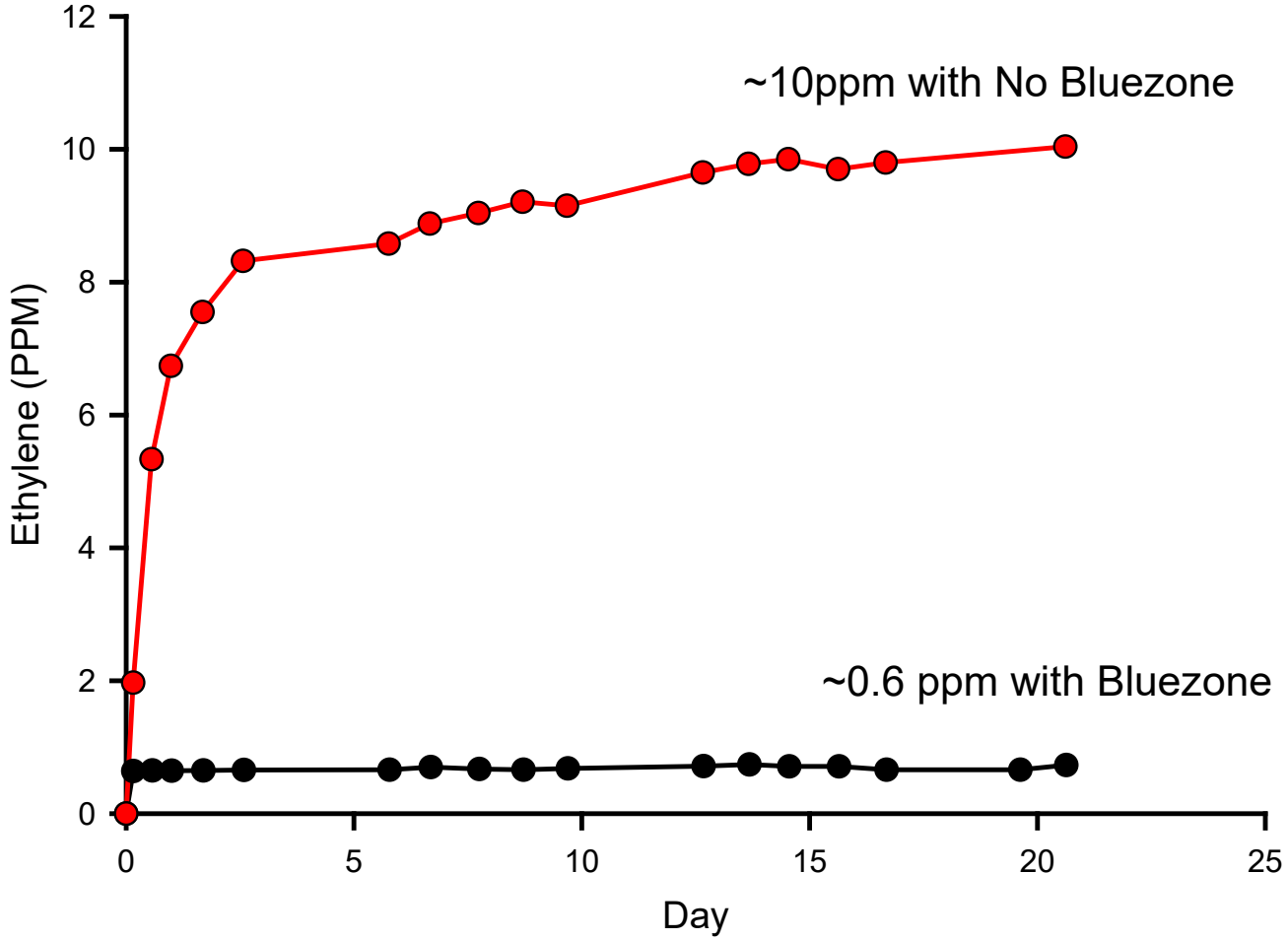
Ethylene concentrations in the Bluezone container were maintained at 0.6 ppm throughout the test, while uncontrolled ethylene rose to about 10 ppm.



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The Bluezone® Technology had significant positive impact on the quality and shelf life of most produce tested.

- Asparagus: reduced rot, stalk damage and discoloration
- Peaches: more firm, less decay
- Cauliflower: reduced surface browning, prevented total of leaves
- Oranges: reduced mold (data from February and July)
- Iceberg Lettuce: reduced browning
- Romaine Lettuce: reduced surface rot and mold
- Melons: Reduced surface mold and decay
- Garlic: reduced cracking, mold and sprouting
- Carrots: less bitter taste (data from February)

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The storage test may not have been long enough to demonstrate the effect of the Bluezone® technology on some produce with long storage life.

- **Apples: After 3 weeks of cold storage, apples in both BZ and Non-BZ trailers were equally firm.**
  - Storage at room temperature for an additional week (with no BZ operating) did not demonstrate a significant difference between BZ and Non-BZ cold storage.
- **Pears: After 3 weeks of cold storage, pears in both BZ and Non-BZ trailers were firm.**
  - Storage at room temperature for an additional week (with no BZ operating) did not demonstrate a significant difference between BZ and Non-BZ cold storage.
- **Cabbage: After 3 weeks of cold storage, red and green cabbage in both BZ and Non- BZ trailers were of equivalent (high) quality.**
- **Celery: After 3 weeks of cold storage, celery quality in both BZ and Non- BZ trailers were of equivalent (high) quality.**

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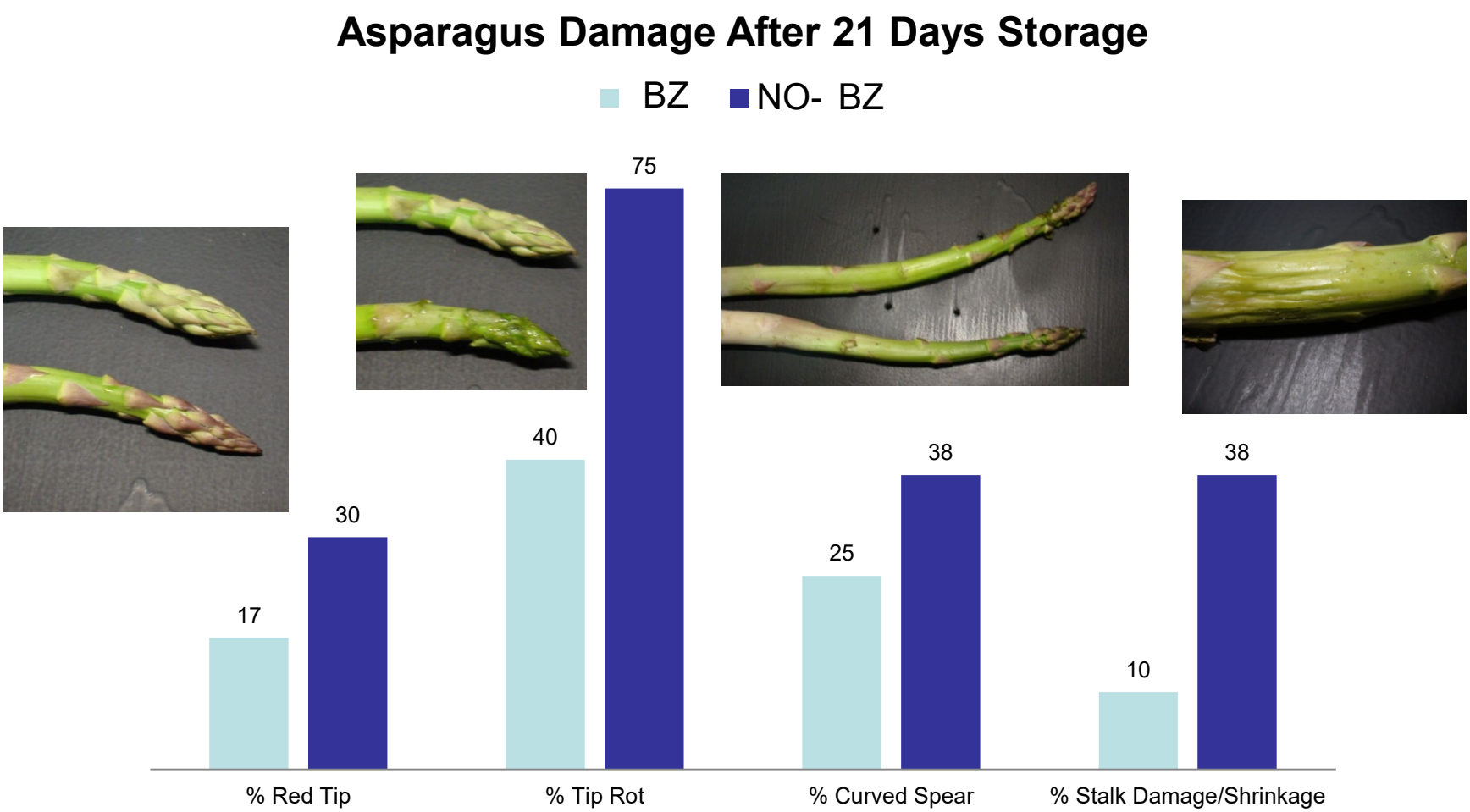
Asparagus Damage is Significantly Reduced with BZ



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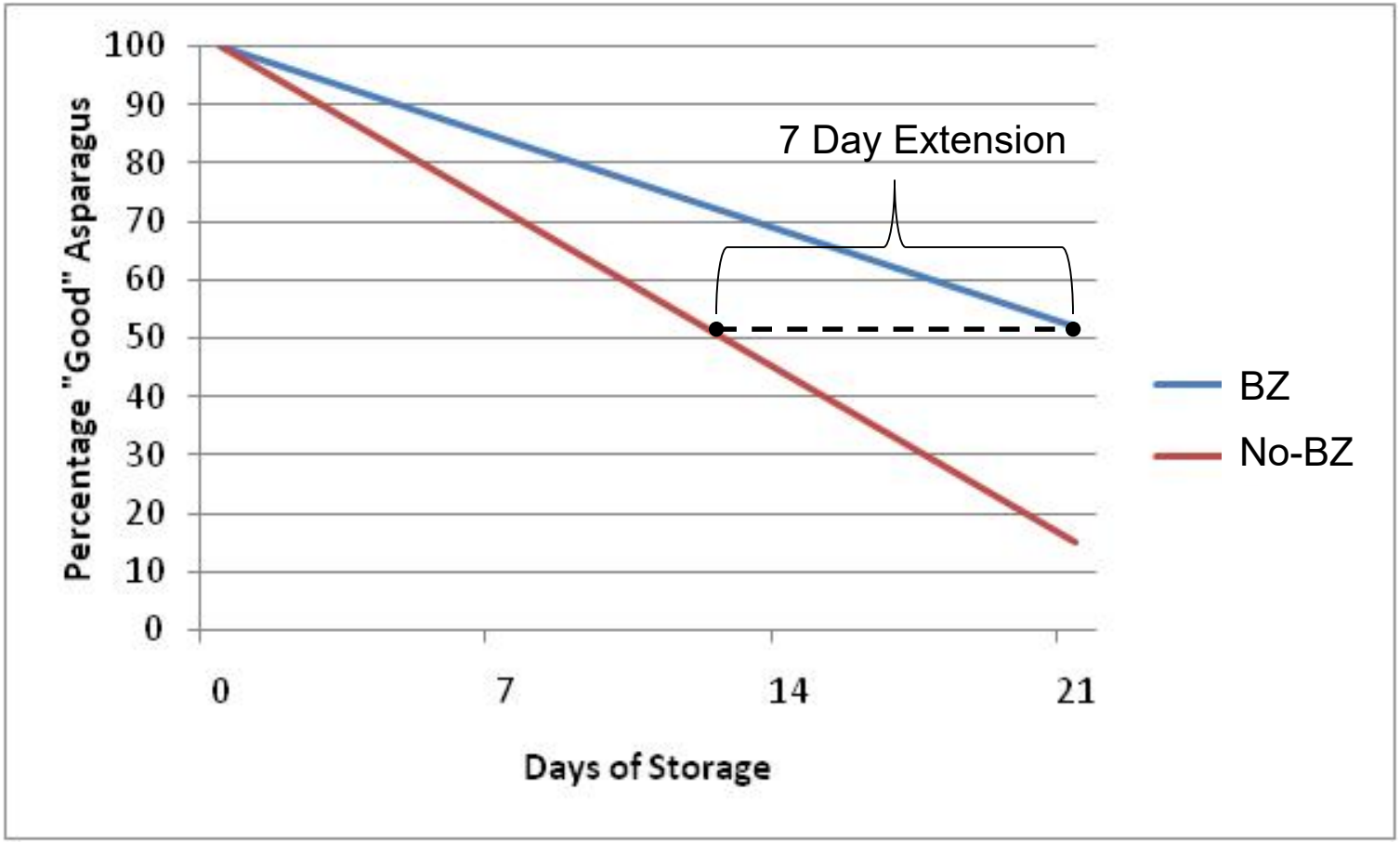
The Bluezone® provided a 7 day shelf life extension for asparagus.



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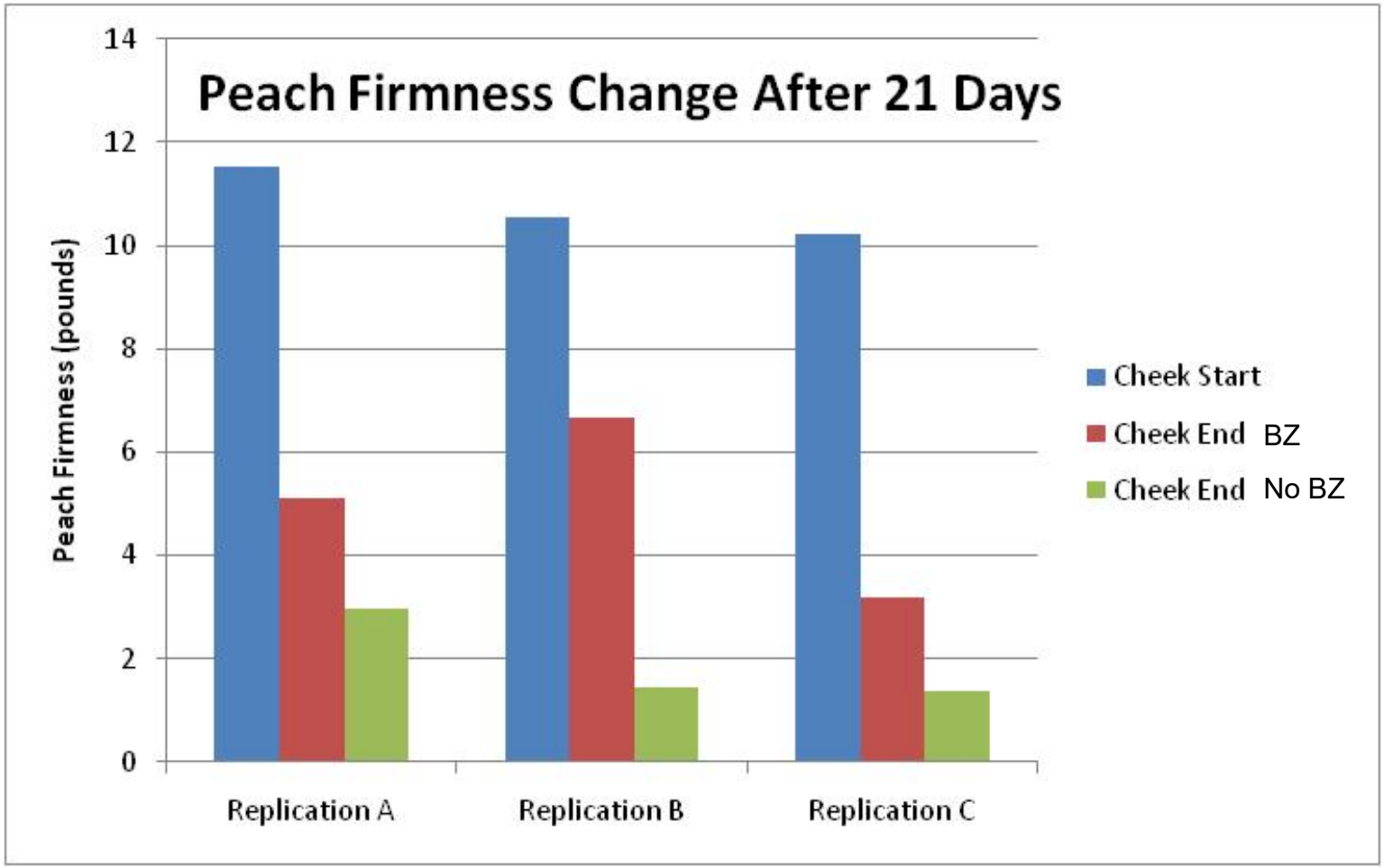
Bluezone Reduces Ripening in Peaches, Firmness is Improved in Peach Cheeks.



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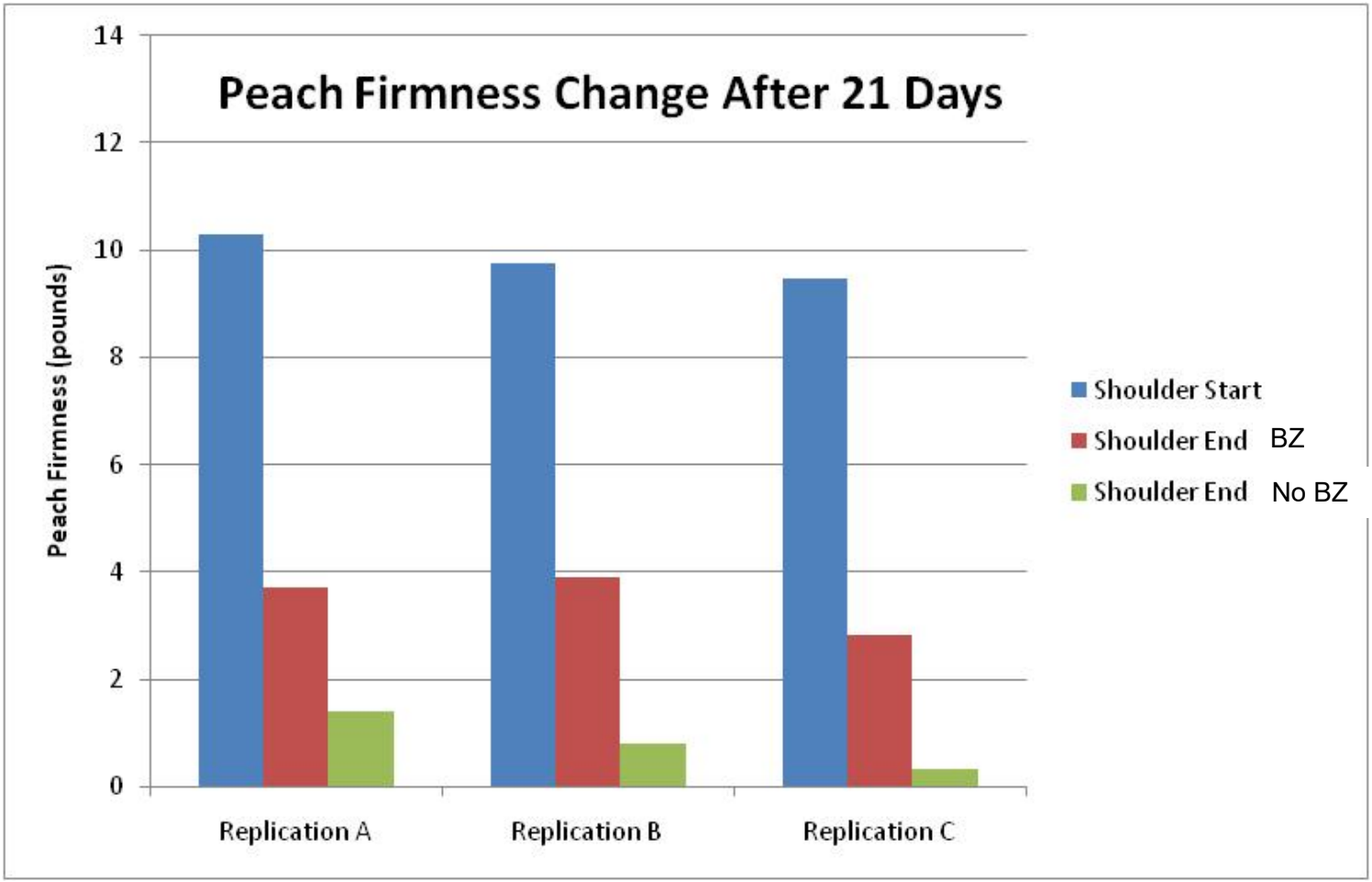
Bluezone Reduces Ripening in Peaches, Firmness is Improved in Peach Shoulder.



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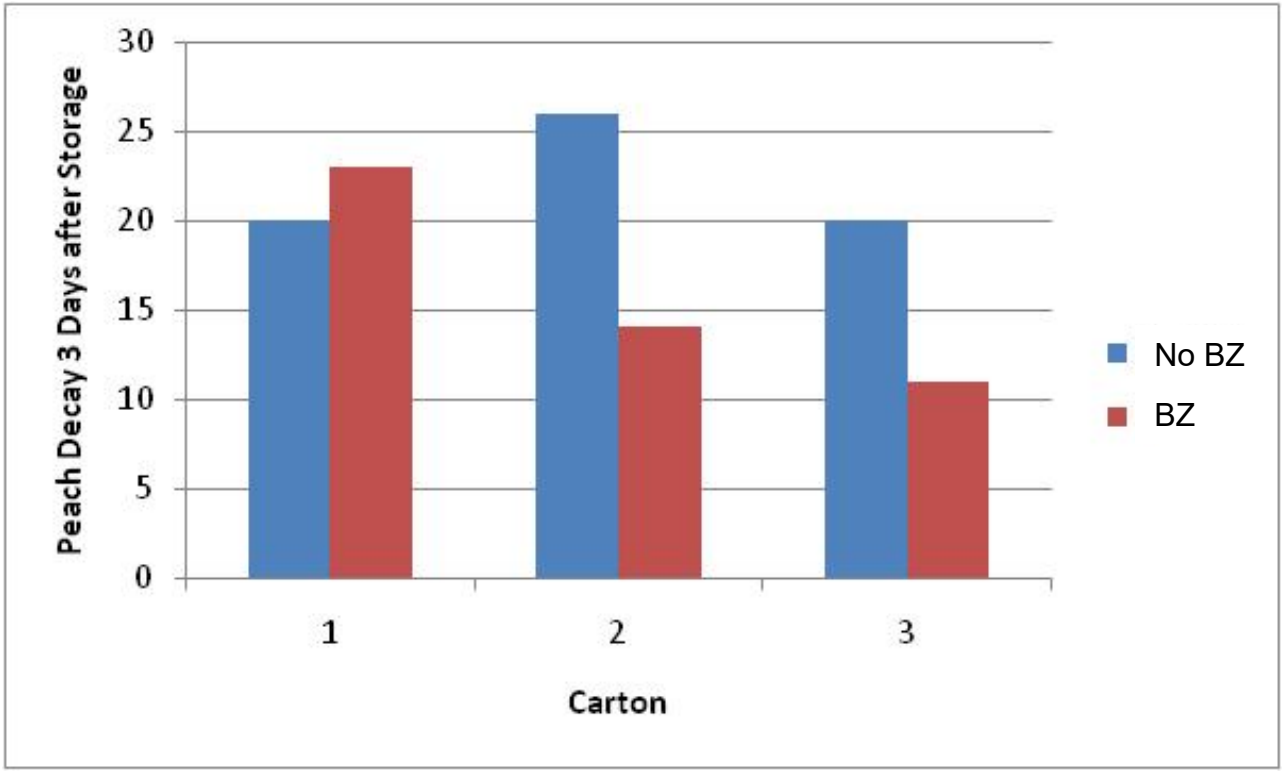
Use of the Bluezone significantly reduced decay in the peaches. Peaches were evaluated for decay after 3 days at ambient temperature after 3 weeks cold storage.



Decay was reduced by 37% with use of Bluezone.

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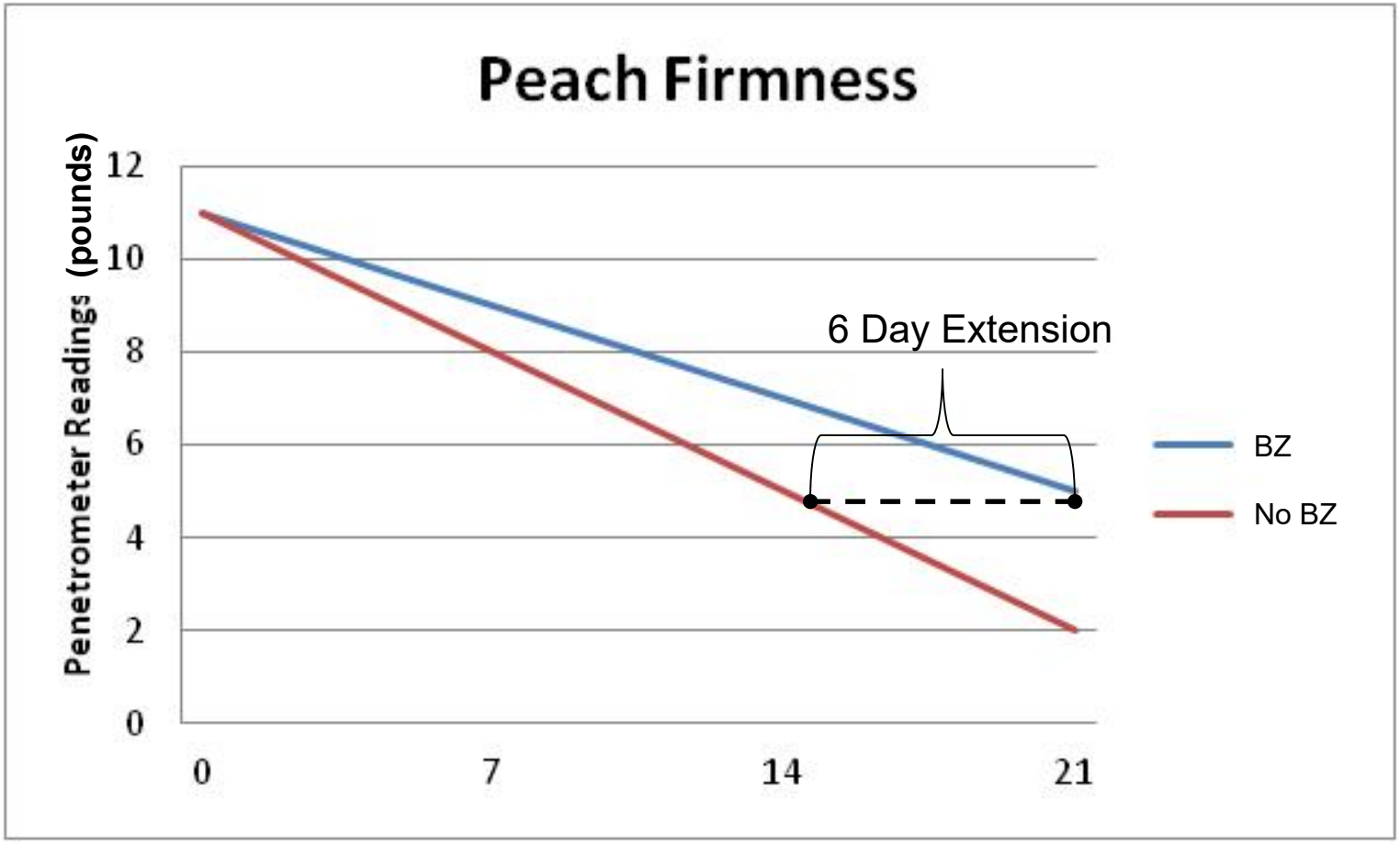
The Bluezone provided a 6 day life extension for peaches.



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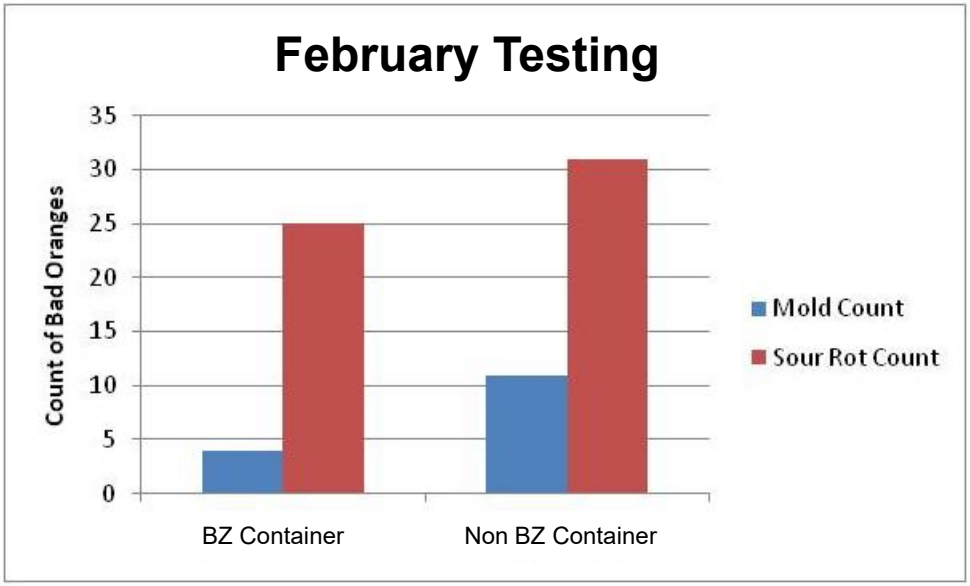
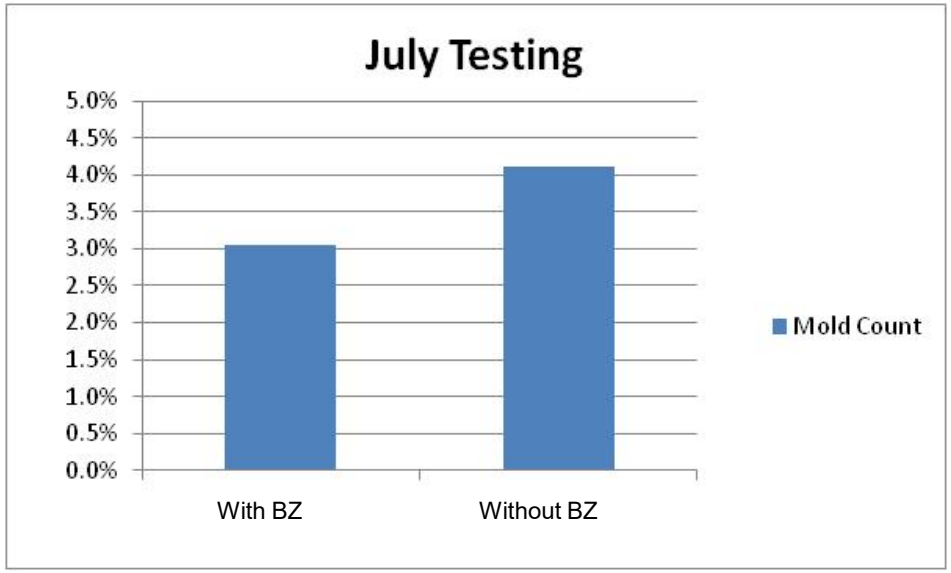
The Bluezone offered an improvement in decay in oranges.



Oranges were evaluated for decay, 5 days after the 3-week cold storage test was completed.



This effect was more pronounced in February Demonstration Testing.

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Cauliflower experienced total, catastrophic loss of leaves over the 21 day test without the use of the Bluezone.

Bluezone

No Bluezone

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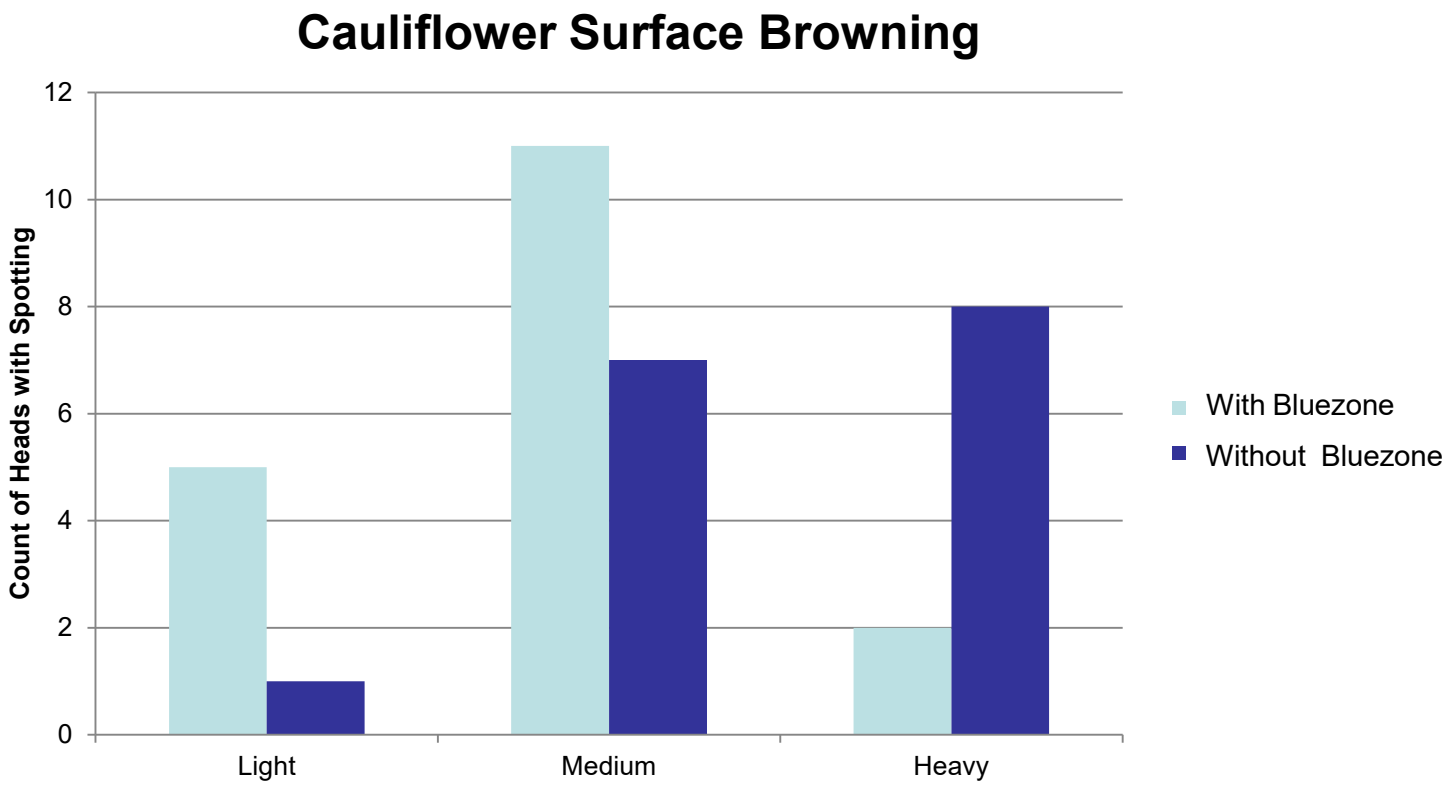
Cauliflower surface spotting was significantly reduced with the Bluezone.



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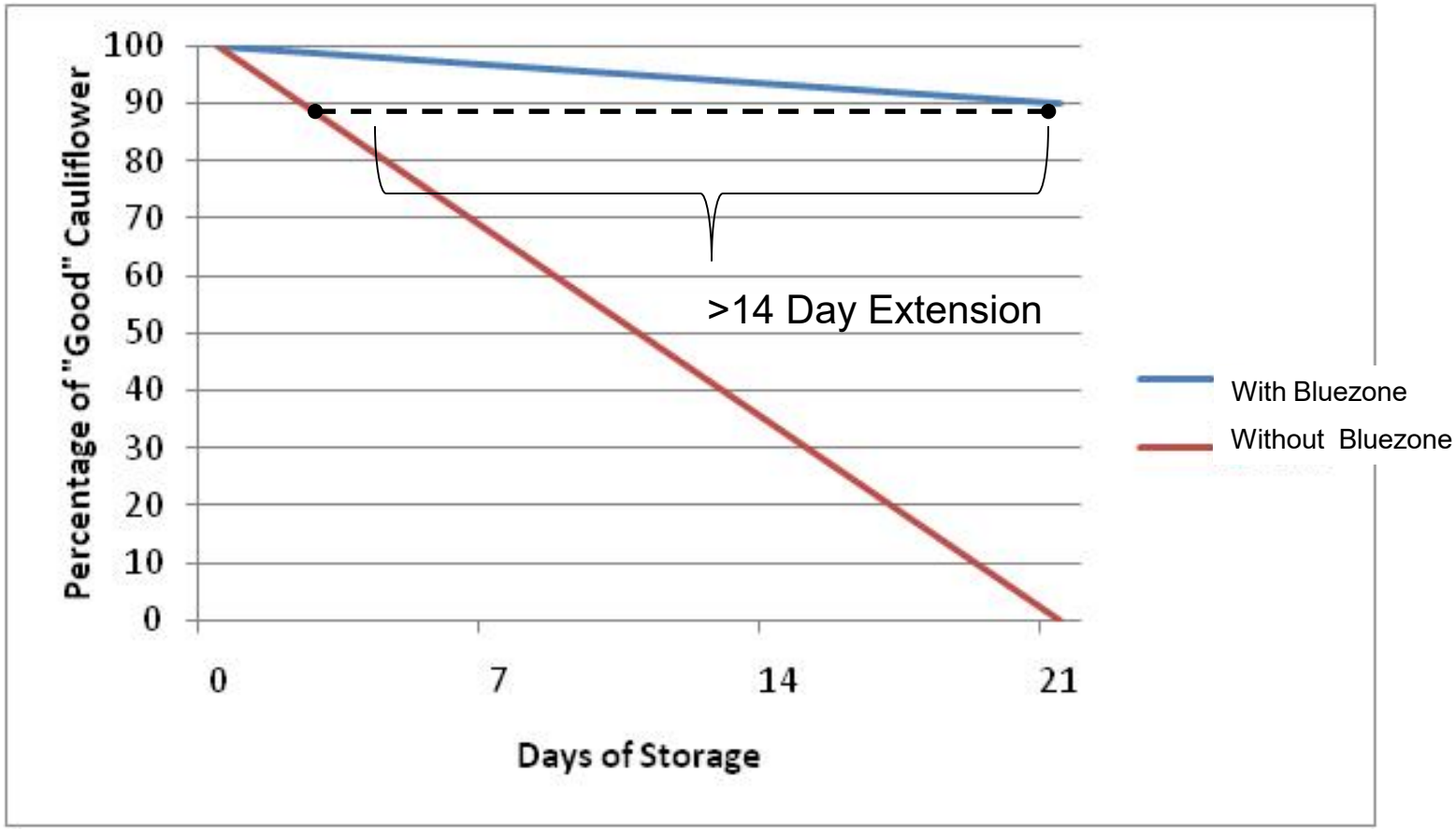
The Bluezone extended the life of the cauliflower by more than 2 weeks.



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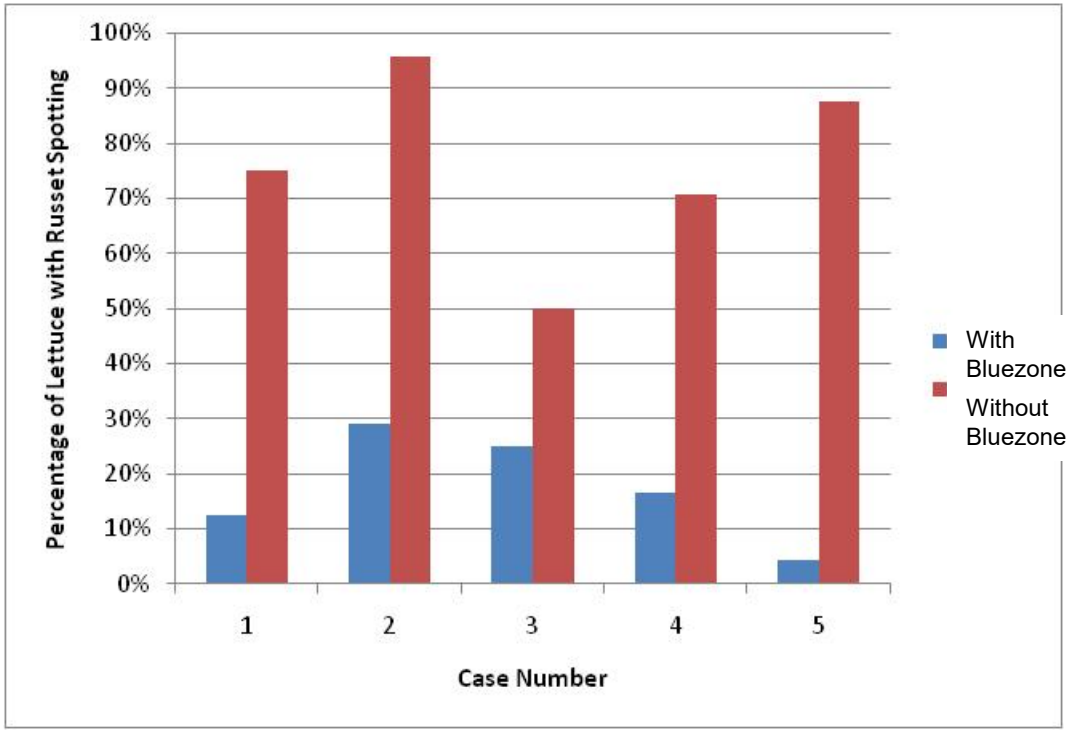
Use of the Bluezone significantly reduced russet spotting in Wrapped Iceberg Lettuce over the 21 day storage period.

Percentage of Lettuce Heads with Russet Spotting



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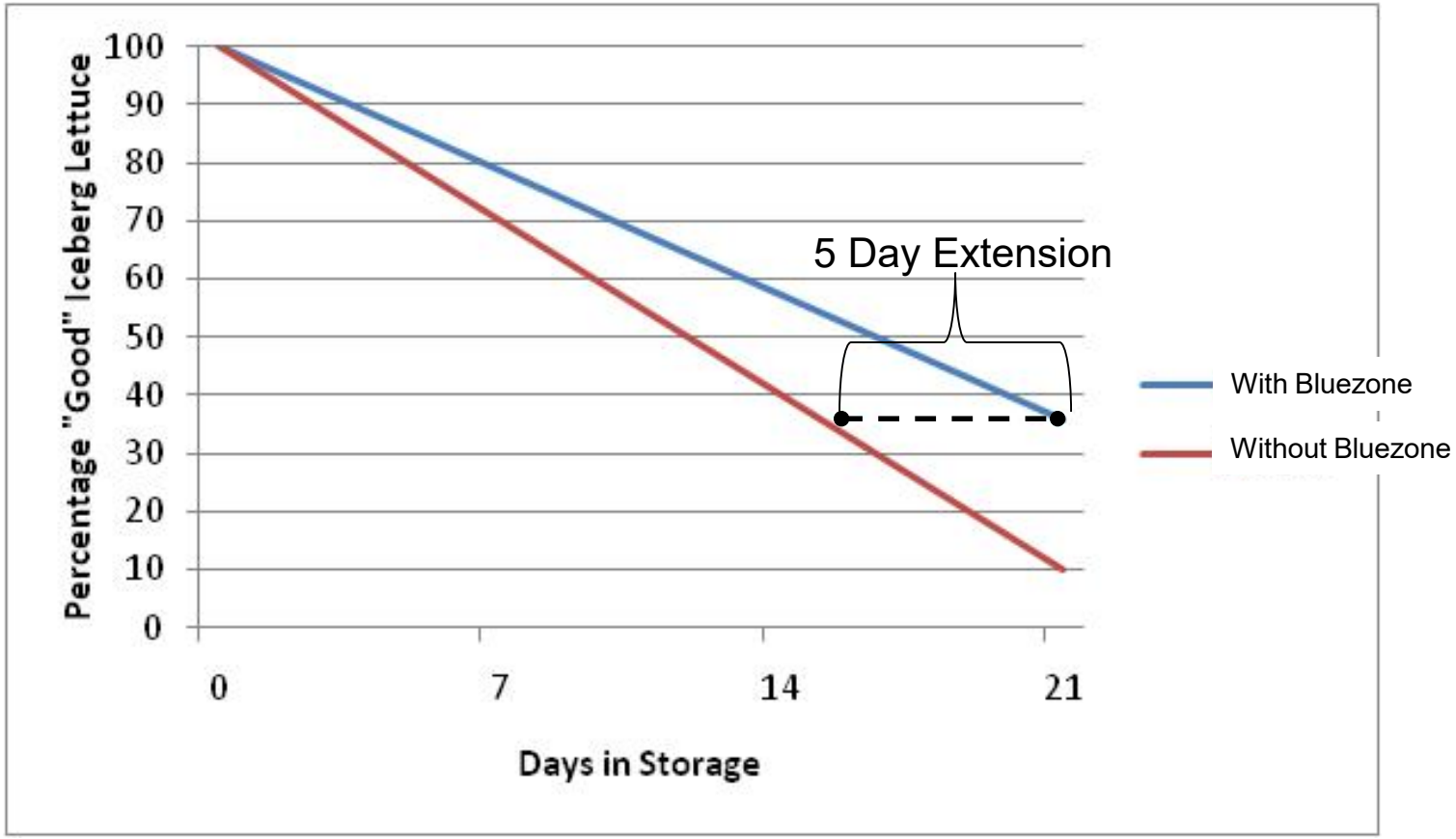
The Bluezone extended the life of the wrapped iceberg lettuce by 5 days.



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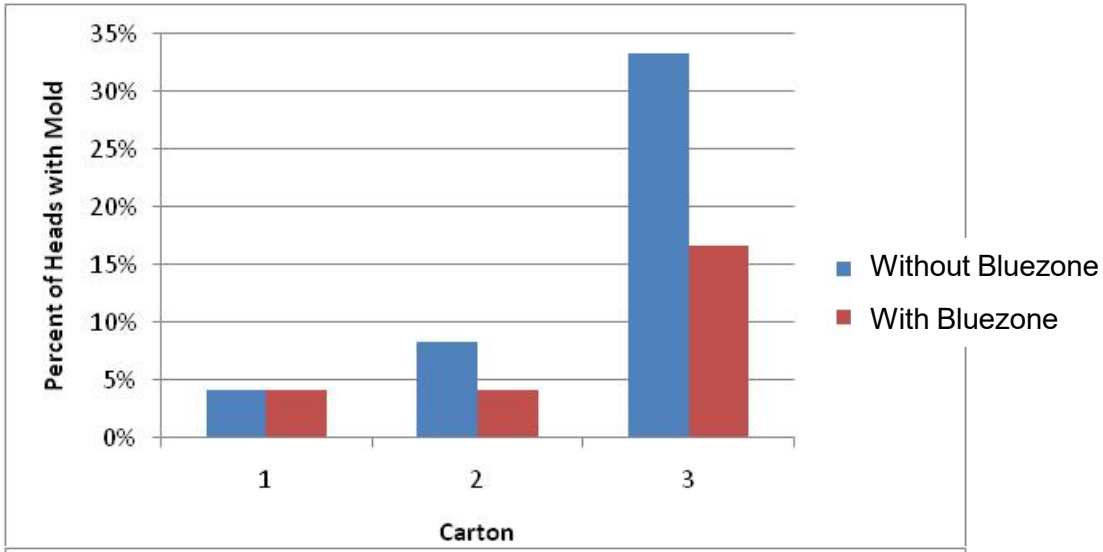
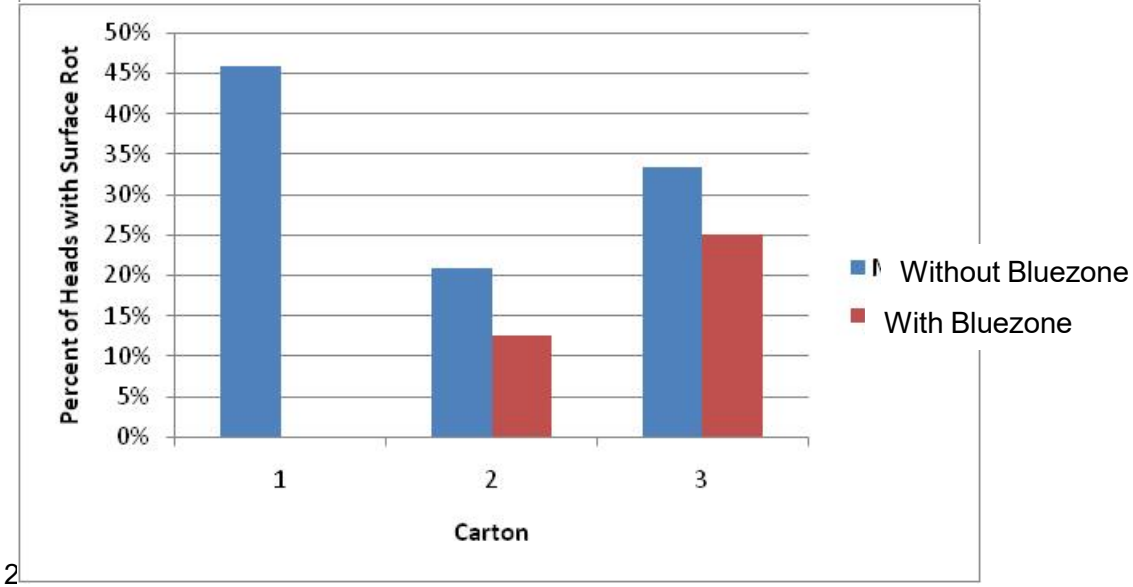
The Bluezone reduced surface rot and mold on unwrapped Romaine Lettuce.





Incidence of stem rot in each treatment was the same.

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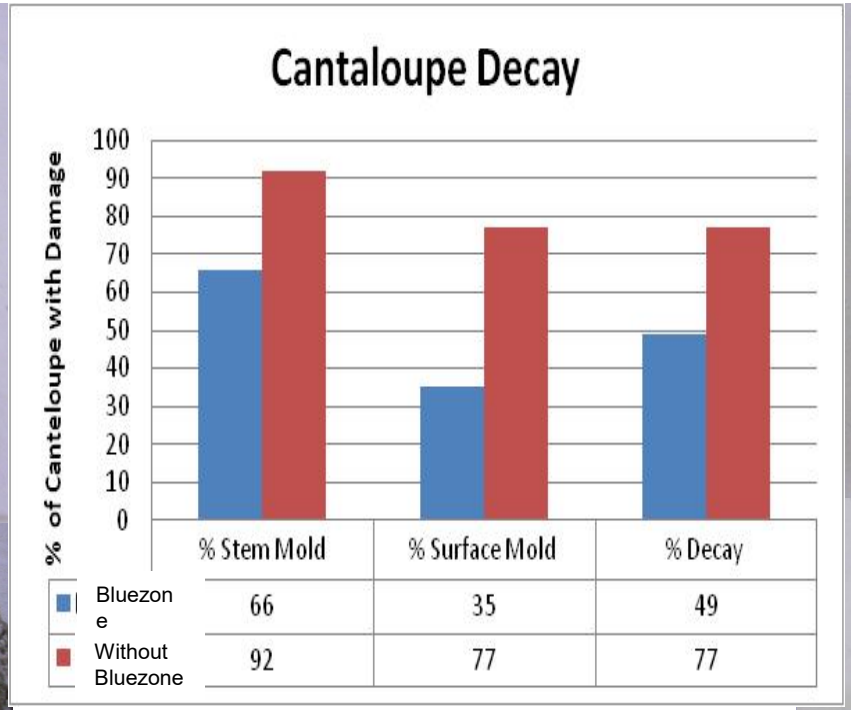
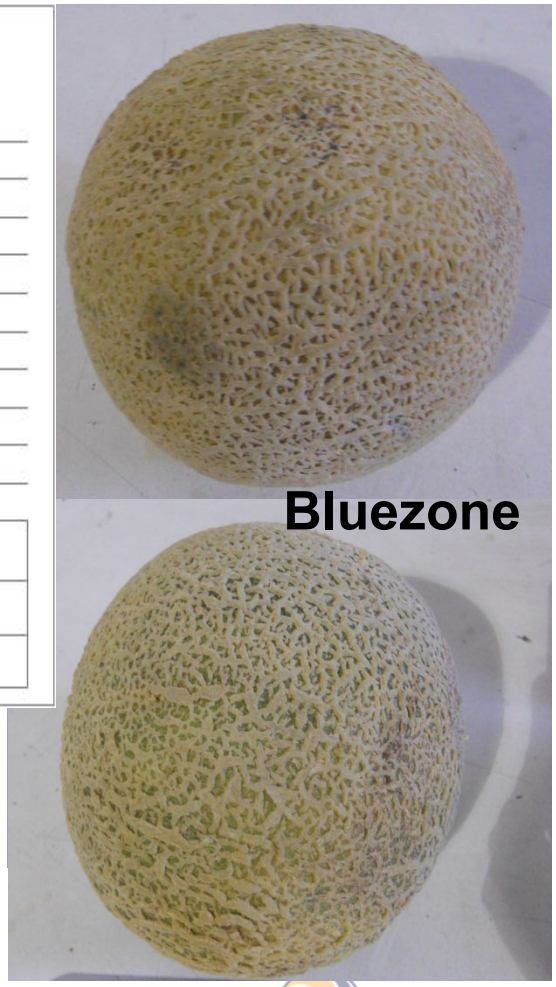
The Bluezone reduced the incidence and extent of surface mold and decay on the cantaloupe melons.





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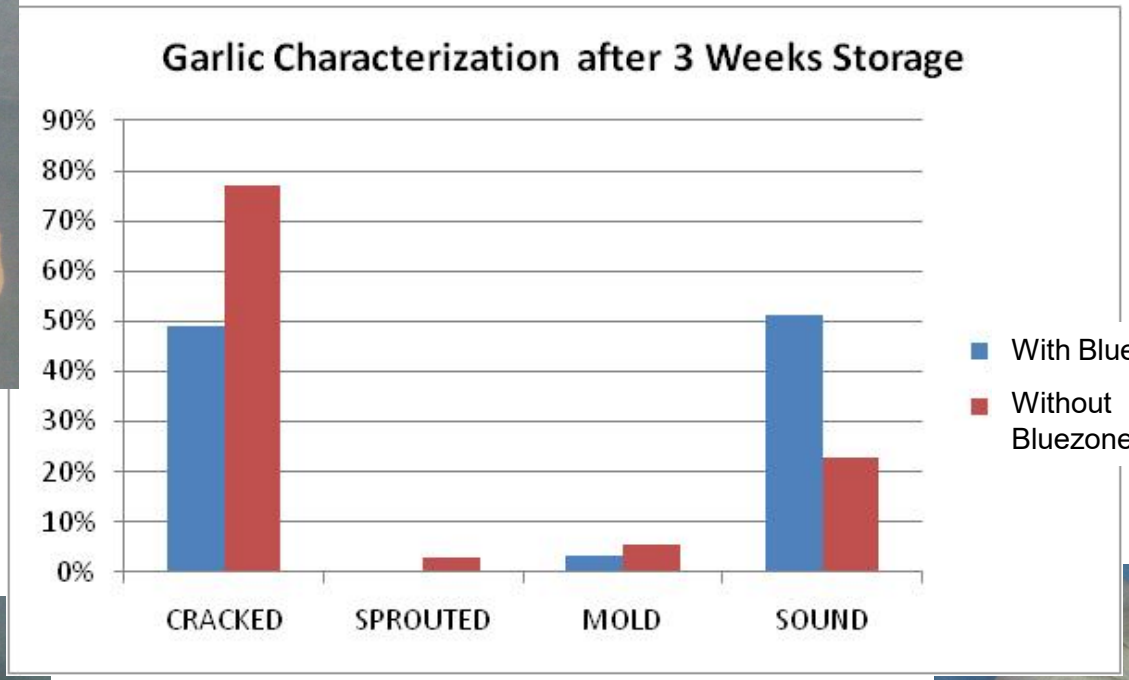
Bluezone use demonstrated significant reduction of cracking, sprouting and mold in Garlic.

Sound

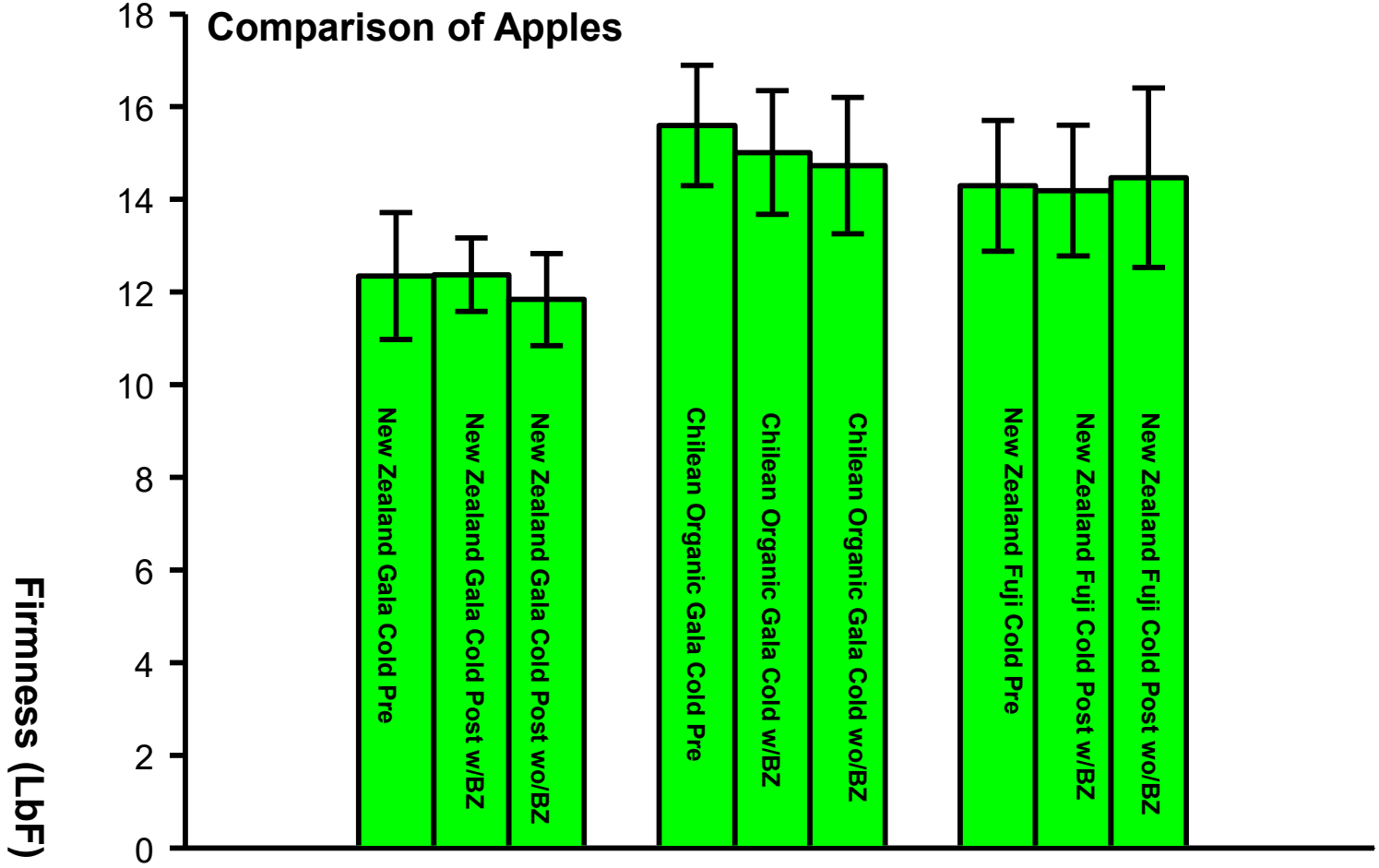


Sound

Cracked

Mold

Apples stored with and without Bluezone had excellent firmness after 3 week of storage.



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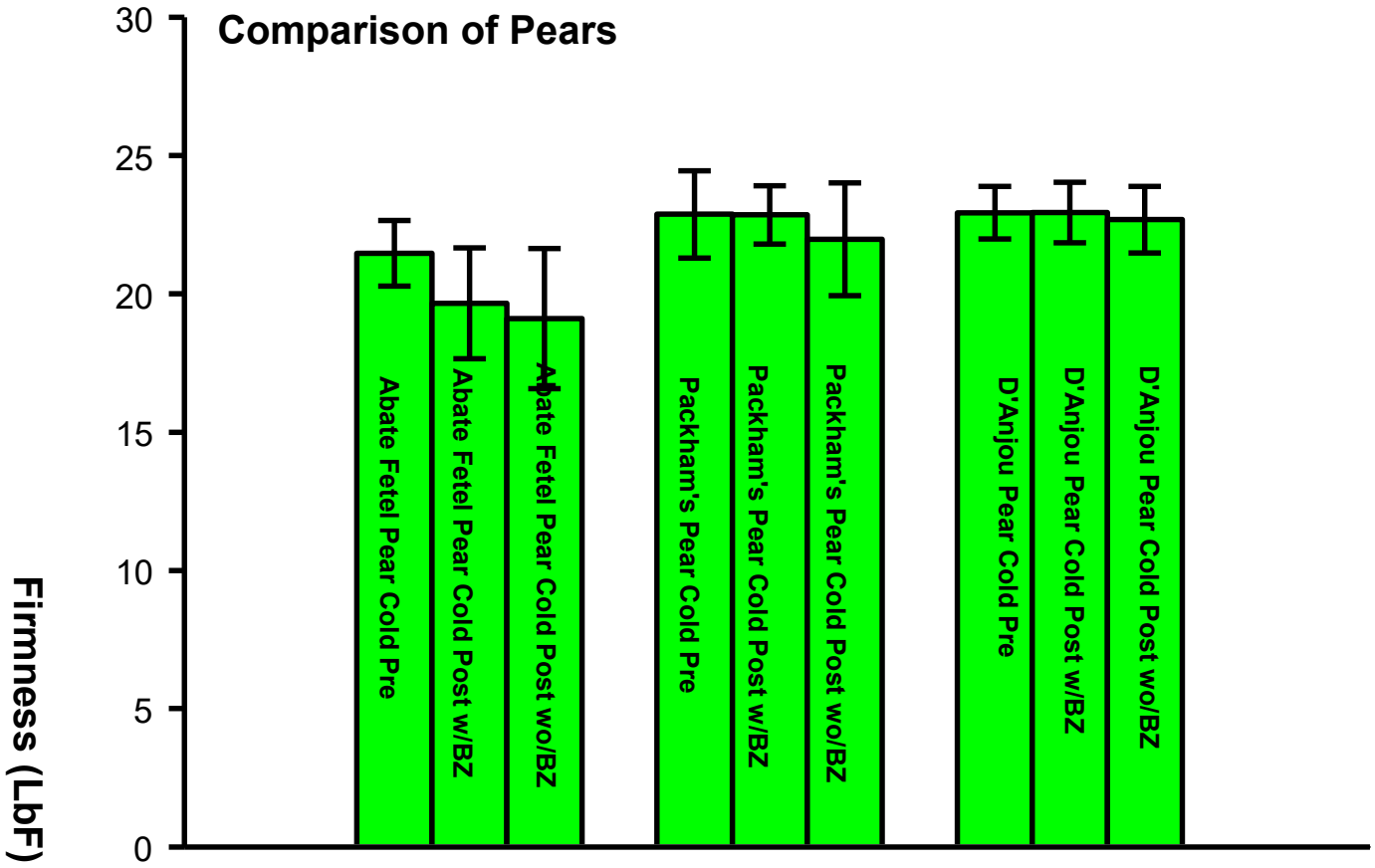
Pears stored with and without the Bluezone had excellent firmness after 3 weeks of storage.



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