Antibrowning: Antimicrobial Research for Fresh-cut Products

Wyatt Brown, Cal Poly, San Luis Obispo ©2013

Control of Browning of Trimmed Artichokes

Desire to market trimmed, ready-to-cook artichokes for both retail and foodservice use

Artichokes brown very quickly and cut areas appear dark brown to black

Darkening appears in as little as 8 seconds

Research funded in part by a California Agricultural Research Initiative grant

Cooperator: Ocean Mist Farms, Castroville

Research conducted to develop a formulation using GRAS ingredients to control pre-cut, fresh-market artichoke browning

Field Fresh

Fresh Xtend

Fruit Fresh®

Hexylresorcinol

Iota carrageenan

Ascorbic acid

Calcium ascorbate

Calcium carbonate

Calcium propionate

Citric acid

Field Fresh

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Hexylresorcinol

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Chemicals Tested
Chemicals Tested

- Isoascorbic acid
- Low methoxy pectin-32
- Low methoxy pectin-35
- N-acetyl-L-cysteine
- NatureSeal
- Polyvinylpolypyrrolidone
- Sodium acid pyrophosphate
- Sodium citrate
- Sodium hexametaphosphate

Methodologies

- ~400 chemical:application methods tested
- Stem disks and whole buds tested
- Tissues vacuum infused (~720 mm Hg), dipped, washed, or sprayed with chemical formulations

Methodologies

- Trimmed buds treated fresh or blanched (110-200 °F, 5-15 sec) then treated
- Artichokes stored in bags, overwrapped trays, or film-sealed trays
- Treated artichokes held at 36-40 °F for up to 14 days

Methodologies

- Trimmed buds also microwaved and the length of time required for 1 or 2 buds, in bags, to be fully cooked was determined (1600W, 120V, 60Hz; Frequency: 2450 MHz)

Methodologies

- Mostly standard ‘Green Globe’ artichoke tested but also ‘Golden Globe’ and variety ‘41’

Results

- Using freshly-harvested artichokes appeared to significantly lower browning rate
- Removing ¾ inch of the bud tip resulted in less and slower discoloration than removing 1.5 inch of the bud tip
Results

- Browning was inhibited more at 36°F than at 40, 41, 45 or 50°F.
- No chemical treatment was able to maintain shelf-life for more than 5-6 days.

Results

- Storing trimmed buds in trays with pads containing antibrowning solution (3-4% calcium ascorbate) maintained fresh-cut appearance of buds up to 28 days at 40°F.

Results

<table>
<thead>
<tr>
<th>Microbial Load (CFU/g) of Stored, Trimmed Artichoke Buds</th>
<th>Days in Storage</th>
<th>3</th>
<th>7</th>
<th>10</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC 40</td>
<td>6.9 x 10^5</td>
<td>4.1 x 10^5</td>
<td>7.4 x 10^6</td>
<td>7.2 x 10^6</td>
<td></td>
</tr>
<tr>
<td>AC 50</td>
<td>2.2 x 10^6</td>
<td>9.1 x 10^6</td>
<td>9.6 x 10^6</td>
<td>4.9 x 10^6</td>
<td></td>
</tr>
<tr>
<td>TCC 40</td>
<td>1.5 x 10^4</td>
<td>1.5 x 10^4</td>
<td>7.6 x 10^5</td>
<td>9.8 x 10^5</td>
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<tr>
<td>TCC 50</td>
<td>1.1 x 10^5</td>
<td>1.7 x 10^5</td>
<td>2.1 x 10^6</td>
<td>1.7 x 10^6</td>
<td></td>
</tr>
<tr>
<td>Y 40</td>
<td>1.6 x 10^4</td>
<td>&lt; 10</td>
<td>8.6 x 10^4</td>
<td>2.3 x 10^5</td>
<td></td>
</tr>
<tr>
<td>Y 50</td>
<td>1.3 x 10^6</td>
<td>7.5 x 10^4</td>
<td>2.3 x 10^5</td>
<td>2.3 x 10^5</td>
<td></td>
</tr>
<tr>
<td>M 40</td>
<td>8.3 x 10^2</td>
<td>2.8 x 10^3</td>
<td>2.5 x 10^4</td>
<td>1.2 x 10^3</td>
<td></td>
</tr>
<tr>
<td>M 50</td>
<td>7.5 x 10^1</td>
<td>8.5 x 10^2</td>
<td>1.7 x 10^3</td>
<td>1.7 x 10^3</td>
<td></td>
</tr>
</tbody>
</table>

AC = aerobic counts, TCC = total coliform counts, Y = yeasts, M = molds.
Microbial Load (CFU/g) of Microwaved, Trimmed Artichoke Buds

<table>
<thead>
<tr>
<th>Sample</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>15</td>
<td>&lt; 10</td>
<td>15</td>
</tr>
<tr>
<td>TCC</td>
<td>&lt; 10</td>
<td>&lt; 10</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Y</td>
<td>&lt; 10</td>
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<td>&lt; 10</td>
</tr>
<tr>
<td>M</td>
<td>&lt; 10</td>
<td>&lt; 10</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>

AC = aerobic counts, TCC = total coliform counts, Y = yeasts, M = molds
6-pack trays were cooked for 10 minutes then turned 180 degrees and cooked 10 more minutes on high power. After cooking, the samples were allowed to steam in the pack for ~5 minutes prior to opening and collection of sub-samples.

Conclusions

- It is very difficult to control browning on artichokes using a simple chemical application
- Control possible if pads employed with overwrapped trays

Conclusions

- Microbial load on artichokes is not excessive, even after 14 days storage at 50 °F
- Microwave cooking of buds effectively sterilizes tissues prior to consumption

Ocean Mist Farms now marketing microwaveable, bagged artichokes

Control of Browning of Sliced Apples

- Outgrowth of research on artichoke
- Research funded internally at Cal Poly
- Industry standard currently 17 day shelf-life at 40-45 °F
• A number of novel formulations tested, not used in artichoke research

Methodologies

• Apples sliced using Sunkist corer/slicer
• Slices submerged in solutions for 1 minute then spun-dried in salad spinner
• Packaged in commercial micro-perforated bags for apple slices (individual serving size)

Methodologies

• Packaged apples held at 40 °F
• ‘Granny Smith,’ ‘Golden Delicious’ and ‘Fuji’ apples were tested
• Evaluated for browning and microbial load: aerobic bacteria, coliforms, E. coli, yeasts and molds

Results

Percentage of ‘Granny Smith’ apples that browned at 40 °F.
Results

Aerobic bacteria (CPU/g) on ‘Granny Smith’ apples held at 40 °F.

Results

Yeast count on ‘Granny Smith’ apples held at 40 °F.

Results

Mold count on ‘Granny Smith’ apples held at 40 °F.

Conclusions

• Apples treated with CP formula marketable for 28 days at 40 °F
• Microbial load for CP-treated apples relatively low for the first 3 weeks of storage

Conclusions

• CP formula superior to current industry standard

CP formula patent-pending

Development of Novel, Antimicrobial Plant Essential-oil Treatments to Reduce the Postharvest Incidence of Botrytis cinerea on Fresh Strawberries

Ryan C. Brantley, Master’s Candidate
• Research funded in part by a California Agricultural Research Initiative grant
• Cooperator: Naturipe Berry Growers, Salinas

Goal
Develop a synergistic formulation of essential oil compounds that will reduce Botrytis cinerea rot of strawberries to 5% during normal shipment and storage

Botrytis Rot

Essential-Oil Volatiles with Anti-Microbial Activity
• Carvacrol (CV) and Thymol (TY): Oregano and Thyme
• Eugenol (EU): Clove
• Citral (CT): Citrus peels
• Linalool (LN): Lavender
• Cinnamaldehyde (CN): Cinnamon
• Methyl Jasmonate (MJ): Jasmine

Trial Series
2011
• Optimize ETOH and MJ levels for 'Albion'
• Combined ETOH + MJ with blends of fungicidal compounds CV, TY and EU

2012
• Inoculation studies
• Combined CT and LN with ETOH and MJ

Methodology
Shelf-life studies 2011
• Commercial strawberries
• Fabric Band-Aid sachets
• ETOH + essential oils
• 1 mil polypropylene overwrap
• 14 days at 40 °F

Inoculations 2012
• Kritzman’s agar
• 0.01 % Polysorbate-80
• Sterile cheese cloth
• Hemacytometer
• 1 % bleach and 3x DI H2O
• 50 ul per berry
Measurements

- Headspace O₂ and CO₂
- Days shelf-life
- Percent rot
- Weight loss
- °Brix

Results 2011

- 400 ul ETOH with 3.5 ul MJ = least rot
- ETOH levels had a rate-dependent effect on O₂ levels within packages
- Blends of CV, TY and EU reduced rot significantly (α = 0.05), but there were off flavors

Sample Trial Results 2011

Results 2012

- Blend of ETOH + MJ + CT + LN = greatest efficacy (α = 0.05) with acceptable flavor
- Highest essential-oil levels (200 ul+) = fruit phytotoxicity
- Shelf-life increased from 1.5-7 days

Sample Trial Results 2012
Sample Trial Results 2012

General Observations

- ETOH and MJ positively affected scent
- Treatments were most efficacious on berries harvested from summer to fall
- No effect of treatments on weight loss or °Brix

Effect on Calyx

Phytotoxic Effect

Untreated Control, 2012

ETOH + MJ + CT + LN
Conclusions

• Combination of ETOH + MJ + CT + LN most efficacious, overall
• Fruit had acceptable flavor
• Highest levels tested were phytotoxic to the calyx and fruit

Control of Pinking of Romaine Lettuce

• Outgrowth of research on apples
• Research funded by Cal Poly’s Packaging Research Consortium
• Research is on-going

Questions?