Utilization of Modified Atmosphere Packaging to Increase Shelf Life

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Fresh Produce is Alive!

FRESH PRODUCE

IS ALIVE

RELEASURES HEAT

BREATHE

LOSES MOISTURE

CAN EVEN DIE

CAN GET SICK
Ongoing Metabolic Activity

RESPIRATION

Sugar + O₂ → CO₂ + Water

Energy

HEAT
Modified Atmosphere Packaging (MAP)

“The practice of changing the composition of the internal atmosphere of a produce bag/tray”

**Air:** 20.95% O$_2$ & 0.04% CO$_2$

MAP typically aims in an atmosphere with:

- Reduced O$_2$
- Increased CO$_2$

- **Respiration Rate**
- **Metabolism**

**e.g. MAP for Spinach:** 3% O$_2$ & 10% CO$_2$ at 0°C (Suslow & Cantwell, 1998)

**Goal:** Maintain quality & extend shelf life

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MAP Types

**Active MAP:** Flushing of the desired gas concentration
  + Rapid Atmosphere Modification
  - Expensive

**Passive MAP:** Atmosphere is modified by product respiration rate & gas permeability of the packaging film
  + Cheap
  - Long period for establishing desired atmosphere
MAP Beneficial Effects

- Slowing down ripening/senescence
- Reduction of produce sensitivity to ethylene
- Alleviation of certain physiological disorders (e.g., chilling injury)
- Reduction of produce susceptibility to post-harvest pathogens (e.g. *Botrytis cinerea*)
- Insect control
- High RH Maintainance
MAP Adverse Effects

Unfavorable MA conditions can cause:

• Initiation of physiological disorders & physiological breakdown

• Irregular ripening

• Development of off-flavors and off-odors

• Increased susceptibility to decay

• Stimulation of sprouting and retardation of periderm development in some root and tuber vegetables

• Moisture Condensation
Temperature is a **CRITICAL** element in MAP Design

- MA packaging is designed for optimum storage temperature

Temperature increase: disparity between increase in respiration rate and film permeability

- **O$_2$** depletion & **CO$_2$** accumulation

- Irregular ripening
- Physiological disorders
- Off-flavors & Off-odor
- Increased susceptibility to decay

Low $O_2$ Injury
High CO\textsubscript{2} Injury

<table>
<thead>
<tr>
<th>Minimum %O₂</th>
<th>Commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific apple cultivars of apples and pears, broccoli, mushrooms, garlic, onion</td>
</tr>
<tr>
<td>2</td>
<td>Most cultivars of apples and pears, kiwifruits, apricot, cherry, nectarine, peach, plum, strawberry, papaya, pineapple, olive, cantaloupe, sweet corn, green bean, celery, lettuce, cabbage, cauliflower, Brussels sprouts</td>
</tr>
<tr>
<td>10</td>
<td>Avocado, persimmon, tomato, pepper, cucumber, artichoke</td>
</tr>
<tr>
<td>15</td>
<td>Citrus fruits, green pea, asparagus, potato, sweet potato</td>
</tr>
<tr>
<td>Maximum %CO₂</td>
<td>Commodities</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Apple (Golden Delicious), Asian pear, European pear, apricot, grape, olive, tomato, sweet pepper, lettuce, endive, Chinese cabbage, celery, artichoke, sweet potato</td>
</tr>
<tr>
<td>5</td>
<td>Apple (most cultivars), peach, nectarine, plum, orange, avocado, banana, mango, papaya, kiwifruit, cranberry, pea, chili pepper, eggplant, cauliflower, cabbage, Brussels sprouts, radish, carrot</td>
</tr>
<tr>
<td>10</td>
<td>Grapefruit, lemon, lime, persimmon, pineapple, cucumber, summer squash, asparagus, broccoli, parsley</td>
</tr>
<tr>
<td>15</td>
<td>Strawberry, berries, fig, cantaloupe, sweet corn</td>
</tr>
</tbody>
</table>
“Postharvest treatments to improve quality and safety of locally-grown vegetables stored at non-optimum temperatures”

Helena P. Chiebao, Jacob R. Jenott, Daniel A. Unruh, Sara E. Gragg, Cary L. Rivard, Eleni Pliakoni
1st Objective
Utilize MAP at non optimum temperature for three different crops – spinach, broccoli, asparagus – to extend shelf life

- Passive MAP bags:
  - Farmers bags (by Chandra Associates) for spinach and broccoli
  - Produce bags (PEAKfresh USA) for asparagus

- Control: non MAP produce bags

- Produce was stored at 55 °F (Optimum ≈ 35 °F)
Conclusions

• Passive MAP bags: extend the shelf life in 4, 7 and 7 days compared to control for asparagus, broccoli and spinach respectively stored at 55 °F

• Could be an alternative for small acreage growers
Extending Shelf-life using Passive Modified Atmosphere

Asparagus

Day 0

MAP Day 14

Control Day 10
Extending Shelf-life using Passive Modified Atmosphere

Day 0

MAP Day 12

Broccoli

Control Day 5
Extending Shelf-life using Passive Modified Atmosphere

Day 0

MAP Day 18

Spinach

Control Day 9
Future Research

• Investigate the use of MAP to **prolong the shelf-life** of organic tomato and spinach during storage in **non optimum** temperatures

  – Investigate the effect of MAP on:
    • Overall
    • Organoleptic
    • Nutritional
    Quality
Questions