I. Introduction

• Definition of “Fresh-cut Produce”
  - Fruits or vegetables that have been trimmed, peeled, and/or cut into 100% usable product to offer consumers high nutrition, convenience, and value while still maintaining its freshness (IFPA, 1997)

I. Introduction

• Total sales of fresh-cut estimated at $27 billion (2016 figures)
  - ~6% Packaged Salads
  - ~27% Vegetables
  - ~12% Fruits

• About 22% of U.S. total produce sales (>$122 billion)

• Most (~60%) sold through food service
  - Restaurants, caterers, hospitals, schools

I. Examples of Fresh-cut Vegetables
  - broccoli and cauliflower (florets and slaws)
  - cabbage (shreds and coleslaw)
  - carrots (shreds, sticks and baby peeled)
  - celery (chopped and sticks)
  - lettuce (shredded, chopped, halved, cored; salad mixes)
  - onions (slices, dices, and whole peeled)
  - peppers (chopped and rings)
  - spinach (washed and trimmed)
  - squash and zucchini (slices)

I. Examples of Fresh-cut Fruits
  - Fruit salads
  - Grapes (washed and de-stemmed)
  - Cantaloupes, honeydews, and watermelons (halves and cubes)
  - Pineapple (cored, slices and cubes)
  - Apple, nectarine/peach, mango, and papaya slices

Intact vs. Fresh-cut

<table>
<thead>
<tr>
<th>Intact</th>
<th>Fresh-cut</th>
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<tbody>
<tr>
<td>Wounding avoided</td>
<td>Wounding normal</td>
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<tr>
<td>Epidermal layer controls water and gas exchange and limits pathogen entry</td>
<td>Epidermal layer removed and interior tissues exposed</td>
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<tr>
<td>Onset of ripening avoided to extend shelf life of climacteric fruits</td>
<td>Fresh-cut fruits must be ripe and “ready-to-eat”</td>
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<tr>
<td>Chilling injury limits shelf life of subtropical &amp; tropical crops</td>
<td>Wounding-induced senescence limits shelf-life</td>
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Wound Physiology

- The injuries to which fresh-cut produce items are subjected in their preparation, trigger shifts in the metabolism of the injured tissues that result in accelerated senescence, ripening, and deterioration.

**Shorter shelf life**

Consequences of Wounding

- Induction of ethylene synthesis.
  - Increased tissue sensitivity to ethylene.
  - Ethylene effects:
    - Phenolic synthesis (browning, bitter flavor).
    - Tissue softening/ouzhening.
    - Yellowing (chlorophyll degradation).

- Elevated respiration
  - Up to 200%↑
  - Decreased respiratory quotient (CO₂/O₂)

Consequences of Wounding

- Enhanced water loss
- Oxidative browning (PPO + phenolics)
- Membrane lipid degradation
  - Increased membrane permeability & ion leakage → water soaked tissues
- Aroma volatile production
  - "Normal" vs. wound-induced aroma volatiles (e.g., cucumber, onion, tomato)
  - Loss of aroma during storage

Fresh-cut Preparation Steps

1. Produce is harvested from the field and put into large bins for the processor
2. "This bulk produce is emptied onto a trim-and-core processing line to remove unusable parts such as the outer leaves, stems and peelings
3. "The trimmed produce then goes through a cutting machine

*Refrigerated operation*

Processing Line

*Refrigerated operation*
Special Treatments

- Anti-microbial compounds
  - Sorbate or benzoate
- Control of tissue softening (fruits)
  - Calcium salts (chloride, acetate, lactate)
- Control of browning
  - Acidification (citric acid), antioxidants (Ca ascorbate, Ca erythorbate)

Temperature Control

- To insure maximum shelf life
- Maintain quality
- Prevent/reduce microbial growth
- Allow modified atmosphere packaging to perform well
Packaging

- Isolate the product (sanitary)
- Reduce water loss (wilting)
- Modify the atmosphere
- Promote sales (attractive appearance)

Microbiology

- Spoilage organisms
  - Fresh-cuts are more susceptible to inoculation and decay than intact produce
  - Spoilage organisms are harmless to humans
- Human pathogens and parasites
  - Bacteria, viruses, and parasites
  - Pathogens can grow (proliferate) on fresh-cuts

Packaging Application

- Select film based on:
  - Cost
  - Appearance (clarity)
  - Sealing properties & strength
  - Printing quality
  - Gas permeability (varies 300-fold)
  - \( \text{CO}_2/\text{O}_2 \) permeability ratio (0.8 to 8)

Edible Coatings on Carrots

- Hygroscopic materials to maintain moist surface appearance
- Sometimes also used to create an internal modified atmosphere

Recommended Conditions

- Prepare fresh-cut products at refrigerated temperature (2-7°C)
- Minimize wounding in preparation
  - Use sharp blades or water knives
- Use good equipment and employee sanitation practices
- All hydrohandling steps require cold (0°C), sanitized water

Recommended Conditions

- Use appropriate chemical treatments to control:
  - Microbes
  - Browning
  - Texture changes
- Package product in MAP
- Handle final product at 0-5°C
- Expected shelf life still only 7-10 days