FRESH-CUT PRODUCTS

DEFINITION
"Fresh-cut produce" is defined as any fresh fruit or vegetable that has been physically altered from its original form, but remains in a fresh state. It has been trimmed, peeled, washed and/or cut into 100% usable product that is subsequently packaged to offer consumers high nutrition, convenience and value while still maintaining freshness.

Not all products in this category are cut into pieces: Leafy salad greens, peeled garlic, individual grapes

However, all products in this category are alive and respire

Minimally processed, lightly processed, partially processed, pre-cut, value-added

*Excludes club stores, supercenters, part of conventional grocery and other alternative formats.

- **Bagged Salads**: 60.6%
- **Value-add fruit**: 11.5%
- **Value-add veg**: 27.9%

Overall Value-Added:
- Retail is about 40%
- Food Service about 60%

Sources: Estimated by Roberta Cook from various sources.

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**Fresh-cut Vegetables**

- Lettuces: cleaned, chopped, shredded
- Spinach, leafy greens, washed & trimmed
- Broccoli & cauliflower florets
- Cabbage, shredded
- Carrots, baby, sticks, shredded
- Celery sticks
- Onions, whole peeled, slices, diced
- Potatoes & other roots: peeled, sliced, diced
- Mushrooms sliced
- Jicama, Squash, cucumber slices, dices
- Garlic, fresh peeled, slices
- Tomato and pepper slices

In 2012 Bolthouse bought by Campbell's
Romaine lettuce, green leaf lettuce and red leaf lettuce, lolla rosa, green tango lettuce, green oak leaf lettuce and red oak leaf lettuce, arugula, mizuna, tatsoi, baby spinach, radicchio, dried pears, frosted almonds, and pear gorgonzola vinaigrette. Ingredients may vary.

Simple lettuce to meal salad

Pear Gorgonzola Kit

http://www.freshexpress.com

Sweetpotato for Food service

Many garlic products

- Reduced prep time-cleaning and trimmed
- Open bag and add seasonings
- Reseal (zip-lock) and microwave

2011 PMA Product Innovation Award

Strips taro, celeriac, sweetpotato

Steam in pouch Brussel sprouts and asparagus
Prepared Vegetables for Home Cooking/Grilling

CARROT CHIPS™
CARROT DIPPERS™
CARROT SNACKS™ for Horses!

United Fresh Produce
Dallas, May 2012

http://www.grimmway.com

Food Service Presentations
Express Gourmet Offerings
Fresh-cut fruits; Salad meals

Chicago O’Hare Airport, 2011

From Snacking in America, NPD report, 2013

Most of snacking is NOT from fruits/vegs
Opportunities for Fresh-cut/fresh prepared Fruits & Veggies
U.S. Supermarket Fresh-cut Fruit Category Shares (% of sales)

- Fruit Mix 21.1%
- Melons 21.6%
- Apples 18.8%
- Pineapple 14.6%
- Trays 18.4%
- Mango 2.2%
- Other 3.4%

2009. Source: Roberta Cook; Perishables Group

Examples fresh-cut fruit products
Lettuce Salad Preparation

- Harvest
- Trim, core, defect removal
- Cool and/or MA
- Dump, mechanical cut
- Cooling, disinfection
- Drying, centrifugation
- Component blending
- Weigh and package
- Metal detector, pack, palletize
- Temporary cold storage
Processing Baby Peeled Carrots

- Washing
- Disinfecting
- Rapid cooling
- Cut to 2 inch sections
- Mechanical Peeling
- Mechanical shaping
- Disinfection
- Cooling
- Computerized quality and color sorting
- Packaging (form, fill, seal)

Trend to automated lines
Minimize personnel at low temperatures
Lower temperature for products
3 separate areas of cleanliness
Many large volume (lettuce) products are mechanically cut, but manual preparation generally results in superior quality

- cutting romaine by hand; eliminate defects
- manually peeled garlic vs compressed air peeled
- broccoli and cauliflower florets manually trimmed
- manually trimmed and cut melons, pineapples

Fresh-cut Products

**Food Safety Requirements**

- Meticulous cleanliness of equipment, employees and product
- Constant monitoring of sanitizer activity
- Rigid maintenance of refrigerated temperatures
- Complete integrity of packages
- Strict adherence to product use by dates & handling instructions
SANITARY PLANT DESIGN: Product, People, Maintenance
Focus: Implementation of GMP’s

- Design efficient, easy to clean & sanitize processing plants
- Mobility of equipment
- 2-3 areas to separate production steps

Vision systems for defect removal
Quick release belts for cleaning
Cutting systems

Rudi Groppe; http://www.heinzen.com/products/

Objective of Wash Water Disinfection
- Prevent Cross Contamination
- May reduce Microbial Load
- Will NOT Sterilize the Product
- Constant monitoring is required

Types of Disinfection Methods
- Chemical
  - Oxidizer, Oxidizer and Acid, Non-Oxidizer
  - Most chlorine based, but continued search for alternatives
- Non Chemical
  - Irradiation (produce), heat, UV, filtration
BABY LEAF LINE
Sanitation vs Production
What is CLEARLY wrong here?

Maintain Quality & Safety of Fresh-cut Vegetable Products

1 Use highest quality raw material
2 Minimize mechanical damage; sharp knives
3 Rinse cut surfaces; remove excess water
4 Maintain strict sanitation; chlorinated water
5 Use appropriate package and atmosphere
6 Maintain product temperature at 1-2°C
Effects of Fresh-cut Processing

• Physical
  – Mechanical shock, remove protective layers
  – Cell fluids on cut surface, gas diffusion
  – Exposure to microbial and chemical contamination

• Physiological
  – Increased respiration, ethylene rates
  – Increases in other biochemical reactions
    • Discoloration and Color
    • Texture
    • Aroma and Flavor
    • Nutritional quality

Main strategy to minimize changes is to use low temperature
  • Product cooled before cutting
  • Product prepared in cold room

Knife/Cutting Blade Sharpness
  • Cut cleanly not crush
  • Better shelf-life
  • Less browning of cut edges

Abnormal peeling of carrots leads to fragmented cell walls that dry out and result in “white blush”; can rehydrate carrots.

New equipment peels and then cuts the carrots; have less problem with “white blush”

Diagrams from Saltveit, UC Davis
• Low temperature minimizes wound response
• Diced onions discolor, decay, soften and lose fluid more readily than whole peeled onions

More cutting, higher respiration rates
Low temperature minimizes respiration
Dices discolor, decay, soften and lose fluid more readily than whole peeled onions

Wounds induce phenolic metabolism
Leading to unsightly brown pigments

Enzymatic Browning

PAL
Phenylalanine → cinnamic acid → other phenolics

PPO
+ O₂
(o-Diphenol oxidase)
(Laccase)

Complex brown polymers ← quinones

PAL = phenylalanine ammonia-lyase
PPO = polyphenol oxidase
Discoloration Rating Scale for Romaine

1=none  2=slight  3=moderate  4=mod. severe  5=severe

Prevention of enzymatic/oxidative browning

- Refrigeration (slows enzymatic reactions)
- Exclusion of oxygen (CA, MAP, edible films)
  - Inhibition of PAL (lettuces & vegs)
  - Inhibition of PPO (fruits)
- Use of reducing agents (ascorbic acid, etc.)
  - Other chemical agents
Examples of benefit of MA and chemical treatments

Romaine 1                     Romaine 2

AIR

MA
(0.7%O₂ + 8%CO₂)

6 days at 5°C

Fresh-cut potato

Control Air Bisulfite Air C.A. + A.A. Air Control Bismuthite MA C.A. + A.A. MA

8 days 5°C; MA =3%O₂ +12%CO₂
C.A.+A.A. =citric acid + ascorbic acid

Packaging is a key enabling technology

Resealable bags

Single serve Snack packs

Steam in Bag

Rigid containers and bowls

Biobased packaging PLA resin

Active packaging

• Oxygen scavengers
• Gas exchange control
• Anti-microbials
• Moisture control
• Odor absorbers
• Self-venting films
• Preservative releasers

Intelligent/Smart Packaging

• Time-temperature indicators
• RFID tags, labels
• Thermochromic inks
• Moisture indicators
• Doneness indicators
• Microorganism indicators
• Freshness indicators
Fresh-cut Packaging

• Bags (LDPE) with holes
  – No modified atmosphere
• Bags with microperforations
  – Often PP
  – Permeability of O2:CO2 =1:1
• Differentially permeable films
  – Layered plastics
  – Co-extruded plastics
  – Gas permeability ratios vary
  – Permeable patches

✓ Often lower O2 and increase CO2
✓ A too extreme atmosphere will lead to fermentation
✓ Temperature abuse leads to undesirable change in atmosphere
✓ An inappropriate atmosphere is worse than no modified atmosphere
Temperature Effects on Retail Packaged Salads

Peiser and Cantwell, UC Davis

Cut Vegetable Quality and Modified Atmospheres

grape tomato
celery sticks
baby carrots
broccoli florets
sugar snap peas

Vegetable trays - want 18 day shelf-life
Products in tray and compatibility issues
- raw material sourcing and handling before prepare
- shelf-life of individual products in tray varies
- temperature; 5°C too low for grape tomatoes
- modified atmospheres—not good for all products in tray
Lettuce Salad Quality Parameters

- Fresh appearance
- No decay
- No discoloration
- Crisp texture
- Good aroma and flavor
- Good nutritional value

To date, these quality components have been undervalued.

Current package atmospheres cause loss in all three.

Temperature Management

- Insures best product quality
- Longest shelf life
- Reduces microbial growth
- Required for MA packaging

Modified Atmospheres are a supplement to but not a substitute for good temperature management.

Modified Atmospheres

- Can be an important supplement to temperature
- Can retard deterioration
- Can retard discoloration in fresh-cuts products
- Can retard microbial growth
Cut Lettuce Alternatives
- Intact Baby size
- Clean Whole leaves
- Hearts of romaine
- Small mixed lettuces
- Organic Spring Mix

Rely on temperature control; No MA used

MA not allowed on mushroom, Clostridium botulinin risks
Chilling sensitive produce needs to be held at low temperature once cut. Relative Importance of Temperature and Modified Atmospheres for Fresh-cut melon:

- 14 D
- 7.5°C (45°F)
- 5°C (41°F)
- 2.5°C (36°F)

1% O2 Air
Air + 10% CO2
1% O2 + 10% CO2

10 days
IMPORTANCE OF TEMPERATURE
Commercial prepared red onion rings and dices stored 9 days.

Notice the quality at 0°C

TEMPERATURE
TEMPERATURE
TEMPERATURE

Good temperature control throughout distribution
Temperatures increase during distribution
Vertical air flow; ice is a problem
<table>
<thead>
<tr>
<th>Products</th>
<th>Potential post-cutting storage life at 2 to 5°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEGETABLES</td>
<td>Days</td>
</tr>
<tr>
<td>Baby carrots, peeled onions, peeled garlic</td>
<td>&gt;21</td>
</tr>
<tr>
<td>Lettuce salads, whole lettuce leaves, mixes small leaves (spring mix, mesclun), spinach leaves, peeled potatoes; sliced root mixtures</td>
<td>14-18</td>
</tr>
<tr>
<td>Broccoli &amp; cauliflower florets, shredded cabbage, shredded lettuce, shredded broccoli stem, celery &amp; carrot sticks</td>
<td>10-14</td>
</tr>
<tr>
<td>Pepper and tomato dices, cucumber slices, squash slices, mushroom slices, jicama sticks</td>
<td>4-9</td>
</tr>
<tr>
<td>FRUITS</td>
<td></td>
</tr>
<tr>
<td>Apple wedges, pineapple chunks, pomegranate arils</td>
<td>10-14</td>
</tr>
<tr>
<td>Strawberry slices, melon chunks, mango cubes, citrus segments, kiwi, peach &amp; pear slices, grape berries</td>
<td>2-9</td>
</tr>
</tbody>
</table>

For quality and shelf-life: All cut products benefit from low temperature, some benefit from modified atmospheres, and a few benefit from additional treatments.

Flavor and nutritional life is about 2/3 shelf-life (appearance)

- Applies to whole products
- Applies to fresh-cut products

Problem: processors and handlers of fresh-cut products focus too much on shelf-life, not enough on flavor quality.
Quality of Fresh-Cut Fruits and Vegetables

Standardization and Inspection

➢ There are no U.S. grade standards for fresh-cut products; raw product standards apply; http://www.ams.usda.gov

➢ The following booklet provides guidelines and definitions for inspection:


Factors affecting the nutritional quality of fresh-cut products

1. Genotypic variation
2. Preharvest factors
3. Maturity and ripeness stage
4. Fresh-cut operations
5. Storage conditions

Generally, post-cutting life based on visual quality ends before significant losses of nutritional content occur (Gil and Kader)
Brassicas have higher respiration rates than lettuces. Freshness of color and flavor ingredients extremely important.

Raw material quality
Some important factors—not always known or controlled

- Cultivar selection
- Nitrogen, fertilization
- Water, irrigation
- Climate and season
- Maturity

<table>
<thead>
<tr>
<th>Defect level</th>
<th>Category</th>
<th>%</th>
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<tbody>
<tr>
<td>None or slight</td>
<td>1 and 2</td>
<td>34.2</td>
</tr>
<tr>
<td>Moderate damage</td>
<td>3</td>
<td>49.2</td>
</tr>
<tr>
<td>Severe damage</td>
<td>4</td>
<td>13.7</td>
</tr>
<tr>
<td>Leaf Pieces</td>
<td>5</td>
<td>2.8</td>
</tr>
</tbody>
</table>
Baby Carrots and Variety Selection

- Uniform, bright orange color
- Small or no core
- High sugars with no harshness/bitterness
- Smooth exterior to minimize peeling loss
- No green should or green core problems
- Strong tops for mechanical harvest
- Balance between juicy texture and resistance to shatter

It is hard to underestimate the importance of varieties

Next Level Fresh Fruit Cuts, a division of Fruit Dynamics, Inc., Fresno, CA, has announced that after 5 years of product development, they have identified the proper cultivars, processes and packaging necessary to commercialize fresh cut peaches and nectarines, in many cases with a shelf life exceeding 15 days.”

400 varieties evaluated
Flavor profile
Resistance to discoloration
Shelf-life requirement

Fresh-cut Fruit Challenges

- Labor Intensive Production
- High Cost per pound-yields and price
- Fruit availability
  - Sourcing domestic and offshore
  - Storage history
  - Stage of ripeness ideal for cutting
    - Maturity at harvest
    - Stage of ripeness; texture
- Perishable cut product
  - Flavor
  - softening, browning
  - microbial
- Flavor quality

Fresh-cut tomato for food service
Shelf-life vs quality
Importance of initial ripeness
Importance of ripening conditions

Color
Texture
Composition-flavor

Difference in juice purge of 2 tomato cultivars
High Quality Fresh-cut Products
Maintain Quality and Safety

- Highest quality raw material
- Minimal cutting damage
- Meticulous sanitation
- Low temperature always and MA if needed
- Less shelf-life for better flavor

freshCUT
The Magazine for Value-Added Produce
http://www.freshcut.com/
Annual guide to suppliers equipment, etc.