Frontier Technology of Identified Thrust Crops of High Value

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<table>
<thead>
<tr>
<th>Potential storage life (weeks)</th>
<th>Optimum storage temperatures</th>
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<tbody>
<tr>
<td></td>
<td>0-2°C</td>
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<tr>
<td>&lt;2</td>
<td>strawberry</td>
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<tr>
<td>2-4</td>
<td>Cherry, peach, plum</td>
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<td>4-6</td>
<td>-</td>
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<tr>
<td>&gt;6</td>
<td>Apple (non chilling sensitive cultivars), pear, kiwi fruit</td>
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**Frontier technology** is so different from the existing technology that the processing plant in use will not be suitable to use the new technology.

Commercialisation of frontier technology would very likely involve new investment.
Thermal processing

- Conventional methods
  - low temperature for long time, eg. canning

- Advanced methods
  - HTST
  - UHT
  - thin profile processing
  - agitation retort processing
  - aseptic processing
Microwave Heating

- Uses industrial, scientific and medical frequencies
- 2450 or 915 MHz
- 12 or 34 cm in wavelength
- Dielectric heating mechanism
- Volumetric heating
- Penetration ability ~ 1-2 cm at 2450 MHz
- Used for defrosting, dehydrating, blanching and pasteurisation
- Drying in combination with conventional hot-air or vacuum drying
Radio-Frequency Heating

- Applies a high-voltage AC signal to a medium placed between parallel electrodes set up as a capacitor
- Heating due to dipole heating and electric resistance heating
- The longer wavelengths permit deeper penetration
- Reduced energy consumption
- Used for thawing, dehydrating, blanching, pasteurisation and sterilisation of processed foods
Ohmic Heating

- Also called electric heating
- Uses food itself as a conductor of electricity that is taken from mains
- Rapid and uniform heating
- Unlimited heat penetration
- Useful for pasteurisation and sterilisation
Definition

Minimally processed or fresh-cut fruit is defined as any fresh fruit or vegetable or any combination thereof that has been physically altered from its original form, but remains in a fresh state. These fruits and vegetables have been trimmed, peeled, washed, and cut into 100% usable product that is largely bagged or prepackaged to offer consumers high nutrition, convenience and value while still maintaining freshness. (International Fresh-Cut Produce Association, 2002)

Characteristics of minimally processed produce

• Fresh
• Provides convenience
• Perishable: shelf life of fruits is 7-8 days, vegetables 10 -14 days
• No waste material
Unit operations in minimal processing

- **Receiving, inspection and storage of raw materials**: processing and storage at 1-5°C

- **Cleaning and disinfection**: clean water, chlorinated water, H₂O₂, ozone, peroxycetic acid, trisodium phosphate

- **Peeling, deseeding, trimming, coring and cutting**: vegetables, mechanically, fruits, manually with sharp knives

- **Washing and cooling**: 0°C, 50-100 ppm chlorinated water

- **Dewatering**

- **Packaging and distribution**: 1-5°C, compartments in packages to prevent vibrations
Factors that affect minimally fresh processed fruit and vegetables decay and shelf life
Principle of the forward-only movement
### Temperature gradient and air flow in the processing unit

<table>
<thead>
<tr>
<th>Raw materials</th>
<th>Trimming</th>
<th>Prewashing</th>
<th>Disinfecting</th>
<th>Rinsing</th>
<th>Draining</th>
<th>Packing</th>
<th>Carton Expedition</th>
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<tr>
<td>Ambient T</td>
<td>12°C</td>
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<td>Positive pressure</td>
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The hurdles concept
Quality aspects for minimally processed produce

- **Cultivar selection:**
  for compatibility with minimal processing, packaging and distribution

- **Optimum degree of ripeness for processing:**
  produce having the best sensory attributes may not be suitable for handling and processing

- **Microbial spoilage:**
  both pathogenic and spoilage microorganisms, fruits with high pH under packaging conditions can promote pathogens like *L. monocytogenes, C. botulinum*

- **Enzymatic browning:**
  physical methods like lowering of temperature and oxygen, use of MAP and edible coatings
Quality aspects for minimally processed produce

• Enzymatic activity:
  chemical methods like inhibiting polyphenoloxidase activity, removal of oxygen and phenolic compounds, use antibrowning agents as dip solutions-
  - ascorbic acid
  - erythorbic acid
  - citric acid
  - malic acid
  - EDTA
  - cysteine and derivatives

• Textural losses:
  - low storage temperature
  - removal of ethylene
  - calcium solution dip
Quality aspects for minimally processed produce

- **Appearance and sensory quality**
  - freshness
  - taste
  - aroma
  - colour
  - texture (for repeated acceptance)

- **Nutritional aspects**
  - calories ↓
  - vitamins ↑
  - minerals ↑
  - phytonutrients ↑
  - fiber ↑
Shelf life extension of fresh cut fruits

- Temperature management: requires control of
  - respiration rate
  - metabolic processes
  - enzyme activity
  - microbial growth
  - storage temperature

- MAP: extends shelf life by minimising
  - water loss
  - ethylene production rate
  - chlorophyll degradation
  - cell wall degradation
  - phenolic oxidation

Use proper packaging material
Shelf life extension of fresh cut fruits

- **Humidity**
  - to restrict water loss from cut surface
  - reduce surrounding temperature
  - increase RH
  - create a barrier

- **Edible coatings**
  - reduce respiration
  - retard water loss
  - prevents colour change
  - improves texture
  - improves mechanical integrity
  - improves handling characteristics
  - retains volatile flavour compounds
  - reduces microbial growth
Non thermal processing technologies

1. High-Pressure Processing

- uses hydrostatic pressure
- requires pressure vessel
- requires pressure transmitting medium: liquid
- batch process for solid foods
- semi-continuous process for liquids
- pressure range is normally 50-1000 MPa
The isostatic principle in high pressure processing
Pressures required to achieve a 5-log cycle inactivation ratio for certain microorganisms, for a 15 min treatment

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Pressure (MPa)</th>
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<tbody>
<tr>
<td>Yersinia enterocolitica</td>
<td>275</td>
</tr>
<tr>
<td>Salmonelle typhimurium</td>
<td>350</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>375</td>
</tr>
<tr>
<td>Salmonella enteritidis</td>
<td>450</td>
</tr>
<tr>
<td>Escherichia coli O157:H7</td>
<td>680</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>700</td>
</tr>
</tbody>
</table>
# Shelf life comparison of orange juice based on sensory evaluation

<table>
<thead>
<tr>
<th>Storage temp. (°C)</th>
<th>Shelf life studies</th>
<th>Thermally pasteurised (80 °C for 30 s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High pressure treated (500 MPa/5min/35 °C)</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>&gt;90</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>&gt;90</td>
<td>47</td>
</tr>
<tr>
<td>10</td>
<td>47</td>
<td>25</td>
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<tr>
<td>15</td>
<td>32</td>
<td>16</td>
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2. **Pulsed Electric Fields**

- application of pulses of high voltage (typically 20-80 kV/cm) to foods placed between two electrodes for less than 1 sec

- extends shelf life of foods
Schematic depiction of mechanism of membrane permeabilization by electrocompressive forces induced by an external electrical field. Increasing treatment intensity will lead to formation of large, irreversible membrane pores.
PEF System
Effect of PEF on microorganisms

• Inactivates cell membrane modifications in permeability and ion exchange

• Changes cell morphology and biochemical reactions

• Causes protein denaturation

• Inhibits genetic mechanism

• Denatures enzymes

• Disrupts ribosome functions
THANK YOU