The Post-harvest Management of Apples, from Hot Water Treatment to Decision Support System.

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SIXTH FRAMEWORK PROGRAMME
Food Quality and Safety

ISAFRUIT

PROJECT
Outline

- Non-destructive measurement of quality
- Sustainable prevention of postharvest rot
- Improved storage systems
- Quality prediction
Post Harvest Chain

Quality determined at harvest!!

- Ripening status
- Size/color/presentation
- Sustainable product
- Biochemical composition
- Potential taste (sugars)
- Sensitivity to defects
- Shelflife
Initial quality: DA meter

- NIR technique
- Portable
- Quality prediction (harvest and storage)

Research:
Golden Delicious, Red Delicious, Pink Lady Galaxy, Elstar, Rubens

Harvest 4 Sept
Harvest 2 Oct
The I$_{AD}$ is calculated as the difference in absorbance at the wavelengths of 670 (chlorophyll-a absorbance peak) and 720 nm (background of the spectrum).

The I$_{AD}$ decreases throughout fruit development and ripening.
Ethylene production (left) and Starch content (right) in relation with DA measurement at 3 harvest dates for Red Delicious apples.
DA meter: results

Distributions of DA index in cv. Cv. Gala

DA-classes for Gala Apples harvested at three times
DA distribution at different harvest dates for Rubens apples

Decline in DA-index during storage at different temperatures
Relation DA and Firmness

Pink Lady: badges of fruit

Elstar individual fruits

Correlation between DA-index and fruit firmness

\[ y = 18.122x + 51.51 \]

\[ R^2 = 0.587 \]

Firmness vs DA

Fruit firmness, N

DA-index
Tools in the chain: DA meter

- Promising technique for several varieties
- Reduction biological variation: selection at harvest
- Measurement in the orchard possible
- Application for more fruits
- Quality prediction (harvest and storage)
- Relationship with other quality attributes
- **Must accepted as a standard tool?!**
Safer Fruit and Environment

Replacing pesticide treatment against Postharvest rot by:

- HWT  Hot Water Treatment
- BCA  Biological Control Agents (Antagonists)
- GRAS  Generally Recognized Safe Substances
Hot Water Treatment
Results of Hot Water Treatment.

Example of results:

- Golden Delicious: 52°C for 40 seconds and 54°C/ 56°C for 20 seconds.
- Braeburn can be safely treated up to 56°C for 40 seconds and 58°C for 20 seconds.
- Royal Gala can be safely treated up to 52°C for 40 seconds and 54°C for 20 seconds.
- Queen Cox can be safely treated up to 54°C for 20 seconds.
Results of Hot Water Treatment.

**BUT:**
- Variation in effects depending to season, orchard, growing area and variety.
- Good result *Nectria* and *Gloeosporium*, not against *Botrytis*.
- Longer immersion time and higher temperature: skin damage.
- Standard protocol for every situation is problematic.
- Logistic problems during harvest.
- Large scale application is difficult.
Hot Water Treatment on peaches

<table>
<thead>
<tr>
<th></th>
<th>peach &quot;Rich Lady&quot;</th>
<th>nectarine &quot;Big Top&quot;</th>
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<tbody>
<tr>
<td>Infected Fruits%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HW 60°C x 20&quot;</td>
<td>84,38% (a)</td>
<td>100% (a, b)</td>
</tr>
</tbody>
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- E I
- b

Infected fruits %: 0, 25, 50, 75
Treatments with GRAS and Antagonists

- Effects of official EU registered Antagonists were ineffective

- Some GRAS treatments were effective:
  - Na-molybdate
  - Peroxyacetic acid
  - Alcohol ethoxylate

Registration is necessary and is time consuming in EU
Storage systems

1-MCP is blocking the ripening process

![Graph showing ethylene production over time with 1-MCP](image)

- Ethylene production [pmol/kg/s]
- Time [hours]

Receptor

1-mcp

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Storage techniques: 1-MCP treatment

firmness after shelf-life at 18°C

Kitteman, Bavendorf
Storage techniques: Dynamic Oxygen Conditions

Principle

Relative respiration

ULO

DCS/DCA

0 % O₂ 21
Dynamic Storage Systems

DCA: Source A. Zanella, Italy

DCS: Source A. van Schaik, Netherlands
Dynamic Oxygen Systems

Influence different technologies on scald Red Delicious

<table>
<thead>
<tr>
<th>Technology</th>
<th>% Scald</th>
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<tbody>
<tr>
<td>ULO</td>
<td>65</td>
</tr>
<tr>
<td>DPA</td>
<td>10</td>
</tr>
<tr>
<td>MCP</td>
<td>5</td>
</tr>
<tr>
<td>DCA</td>
<td>2</td>
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Skinspots and DCS after 1 Week 18°C

<table>
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<tr>
<th>Orchard</th>
<th>ULO</th>
<th>DCS</th>
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<tbody>
<tr>
<td>11330</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>10412</td>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>10350</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>10069</td>
<td>1.6</td>
<td>0.8</td>
</tr>
<tr>
<td>avg</td>
<td>1.3</td>
<td>0.5</td>
</tr>
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Dynamic Control System (DCS)

Distribution firmness of apples after 7.5 Month in storage direct en 1 wk shelflife
CA and DCS storage with and without 1-MCP (Elstar)

![Graph showing distribution of firmness of apples stored with and without DCS and 1-MCP (Elstar).]
Interactive Storage systems (DCA\DCS\ILOS)

 Advantages

- Orchard related storage condition
- Retention of firmness and ground color in the chain
- Reduction of biological variation
- Reduction of physiological disorders
- Replacement of chemical treatments
- Allowed for organic fruits

 Necessary:

- More equipment
- Special sensors
- Gastight rooms
Decision Support System for Simulation of Postharvest Quality Changes in Fruit Supply Chains

Pawel Konopacki et all
**Peaple** is a prototype Decision Support System to:

simulate quality changes of apples and peaches along different supply chains to meet the demands of consumers and consequently stimulate the increase of fresh fruit consumption.
Peaple contains models for several apple and peach quality indices:

- firmness
- acidity
- soluble solids content
- skin colour
- disorders
- helpsystem
Included in *Peaple*:

1. Cultivars
2. Growth location
3. Harvesting time
4. Transport (conditions)
5. Storage: CA, 1 MCP, DCA, HWT
6. Distribution (conditions)
7. Shelflife
"Peaple" is a useful tool for producers and distributors to verify and increase apple and peach quality in order to fulfill consumer expectations.
Conclusions

- Improvement Non Destructive measurement of Quality
- Non Chemical treatments against Post Harvest Rot in some cases possible.
- New storage systems successful on the market
- Prototype DSS system for quality
Thanks for your attention!