Quality Assurance, Food Safety and Standards for Market Opportunities in Tropical Fruits

By
Prof. Abu-Bakr Ali Abu-Goukh
Topics:

1. Introduction.
2. Harvesting.
4. Temperature Management.
5. Control of Relative Humidity.
7. Control of Pest and Diseases.
8. Special Chemical Treatments.
1. Introduction:

- A number of post-harvest technology procedures have been developed for:
  - Quality Assurance
  - Food Safety
  - Good Market Opportunities

In the Tropical Fruits…
Today, enormous volumes of quality horticultural crops produced, are made available to millions of people through improved post-harvest technology procedures.

Historically and by necessity, post-harvest technology is part of the normal development process in agriculture.

Traditional effective methods for preventing and reducing post-harvest losses, such as maintenance of continuous supply, storage for restricted periods, and processing, should not be ignored.
Many post-harvest losses are direct results of factors before harvest.

Fruits that are:

- infected with pests and diseases,
- inappropriately irrigated and fertilized,
- generally of poor quality before harvesting,

**Can Never be Improved by Post-Harvest Treatments.**

Very often the rate of commodity loss is faster if the quality at harvest is below standard.

Thus, the processes of attainment and maintenance of quality from production, harvesting, handling and marketing must be considered a unified system.
Post-harvest technology procedures should be adopted to:

- Minimize deterioration.
- Reduce post-harvest loss.
- Maintain quality.
- Extend shelf-life.
2. Harvesting:

- Harvesting refers to the gathering of the fruits from the orchard:
  - at the proper level of maturity,
  - with a minimum of damage,
  - as rapidly as possible,
  - at a minimum cost.

- Harvesting at the proper level of maturity is essential for good quality produce.

- Over-maturity or under-maturity will affect the quality adversity, and should be avoided.
Method of harvest should protect the produce from any injuries or bruises.

Suitable harvesting tools, hand gloves, containers and supplies are needed by the harvesters.

Careful field supervision is the most critical factor in protecting fruits from injuries.
Most fresh market tropical fruits are now harvested by hand, because humans can accurately select for maturity and can handle the fruits with a minimum of damage.
Poor harvesting methods lead to deterioration of the Crop
Improvement of harvesting method reduces post-harvest losses and maintains quality
Improved Harvesting

Traditional Harvesting
The improved harvesting method decreased respiration rate, reduced weight loss, delayed fruit ripening and senescence, improved quality and extended shelf-life of mangoes, papayas and grapefruits.


(Elshiekh and Abu-Goukh, 2008)
## Harvesting Method and Quality Grades of Papaya Fruits

<table>
<thead>
<tr>
<th>Harvesting Method</th>
<th>Quality Grades</th>
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<tbody>
<tr>
<td></td>
<td>V. Good</td>
</tr>
<tr>
<td>Traditional</td>
<td>0</td>
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<tr>
<td>Improved</td>
<td>21.6</td>
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### Mango fruits in the different quality grades harvested by the traditional and improved harvesting methods

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Harvesting Method</th>
<th>Quality Grades</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>V. Good</td>
</tr>
<tr>
<td>Dr. Knight</td>
<td>Traditional</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Improved</td>
<td>21.4</td>
</tr>
<tr>
<td>Abu-Samaka</td>
<td>Traditional</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Improved</td>
<td>20.3</td>
</tr>
</tbody>
</table>

Grapefruits in the different quality grades harvested by the traditional and improved harvesting methods

<table>
<thead>
<tr>
<th>Harvesting Method</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>V. Good</td>
</tr>
<tr>
<td>Traditional</td>
<td>1.5</td>
</tr>
<tr>
<td>Improved</td>
<td>21.8</td>
</tr>
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</table>

Horticultural products due to their soft texture should be handled gently to minimize bruising and breaking of the skin.

The skin of horticultural products is an effective barrier to most pathogenic bacteria and fungi that cause rotting of the tissue.

Gentle handling of horticultural products should be promoted at all stages of the marketing channel as means for reducing post-harvest losses and maintaining the quality of the produce.
Good temperature management is the single most important tool that we have to maintain post-harvest quality and to extend shelf-life horticultural products.

Proper temperature management begins with temperature protection in the field, which involves:

1. Harvest during the cool early morning hours.
2. Shading the harvested fruits to minimize warming and sunscald.
3. Quick handling and cooling to minimize high temperature exposure.
Most horticultural crops store best in an environment that has a relative humidity of 85-95%.

Such high humidity retards wilting and maintains the better conditions.

Relative humidity can influence:

1. Water loss.
2. Decay development.
3. Some physiological disorders.
4. Fruit ripening.
Relative humidity control can be achieved by one or more of the following procedures:

1. Addition of moisture to the air by use of humidifiers.
2. Regulation of air movement and ventilation.
3. Use of moisture barriers; such as:
   - Insulation of storage rooms.
   - Polyethylene liners in containers.
   - Plastic films for packaging.
   - Waxing of fruit.
Topics:

1. Introduction.
2. Harvesting.
3. Temperature Management.
5. Control of Relative Humidity.
6. Preparation of Tropical Fruits for Marketing:

- Horticultural commodities may be prepared for market and packed:
  1. In the field (Field packing).
  2. In simple packing stations.
  3. In packinghouses.

- Packinghouse Operations include:
  1. Receiving.
  2. Washing.
  3. Drying.
  4. Waxing.
  5. Sorting.
  7. Sizing.
  8. Packaging.
Dumping

Washing

Sorting

Electronic Sizing

Post-Harvest Technology Procedures
Packaging

Labeling

Stacking

Packed Mangoes

Post-Harvest Technology Procedures
7. Control of Pest and Diseases

- Post-harvest procedures, leading to the maximum physiological life of a commodity, are often those which minimize fungal rots.

- Maintaining a fruit at high vitality, enhances its natural disease resistance and ability to heal wounds.
Principles of disease control include:

- **Prevention:**
  
  “Prevention is better than cure”.

- In most instances, control of post-harvest wastages should commence before harvest, in the field or orchard.

  - Propagating materials should be virus free and bacterial free.
  
  - Sources of infection should be eliminated and sprays for the control of the causal organisms or vector should be applied.
- Careful handling during harvesting can minimize mechanical injury and can reduce subsequent wastage due to microbial attack.

- Chemical protection by using fumigation or fungicide treatment.

- Heat treatment in the form of either moist hot air or hot water dips (50 – 55 °C) have some commercial application for control post-harvest pest and diseases in papayas and mangoes.
Retardation of Microbial Growth can be employed through:

a. Temperature Control:
   ✓ Low temperature handling and storage is the most important physical method of post-harvest wastage control.

b. Modified Atmosphere:
   ✓ Very low O₂ and high CO₂ can slow down and control fungal growth.

c. Fumigation: [Such as sulfur dioxide (SO₂)].

d. Radiation:
   ✓ Ionizing radiation are effective in inhibiting microbial growth, but can cause physiological damage.
The effect of waxing and fungicide treatment (Benomyl) on quality and shelf-life of mangoes and grapefruits was evaluated.
Waxing the fruits decreased respiration rate, reduced weight loss, delayed fruit ripening and senescence, retained ascorbic acid, improved quality and extended shelf-life of mangoes, guavas, papayas, limes and grapefruits.

**Effect of waxing and fungicide treatment on quality of mango fruits**

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Treatment</th>
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<tr>
<td></td>
<td></td>
<td>V. Good (%)</td>
</tr>
<tr>
<td>Dr. Knight</td>
<td>Untreated</td>
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<tr>
<td></td>
<td>Waxed</td>
<td>19.7</td>
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<tr>
<td></td>
<td>Waxed + Fungicide</td>
<td>22.3</td>
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<tr>
<td>Abu-Samaka</td>
<td>Untreated</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Waxed</td>
<td>21.6</td>
</tr>
<tr>
<td></td>
<td>Waxed + Fungicide</td>
<td>24.1</td>
</tr>
</tbody>
</table>

*Mohamed and Abu-Goukh, (2003)*
**Effect of waxing and fungicide treatment on quality of ‘Foster’ grapefruits**

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<tbody>
<tr>
<td></td>
<td>V. Good (%)</td>
</tr>
<tr>
<td>Untreated</td>
<td>5.0</td>
</tr>
<tr>
<td>Fungicide</td>
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</tr>
<tr>
<td>Waxed</td>
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<td>14.0</td>
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Post-Harvest Technology Procedures
The effect of paper and polyethylene package lining on quality and shelf-life of bananas, mangoes and papayas was evaluated.
Package lining significantly delayed fruit ripening, maintained quality and extended shelf-life of banana, mango and papaya fruits.

- Weight loss was reduced in papayas by:
  - Paper lining .................. 9.5 %.
  - Film lining ................... 20.8 %.

- Banana fruit ripening was delayed by 6 - 7 days in the perforated and sealed polyethylene film package lining with GA3 treatment (100 ppm). (Osman and Abu-Goukh, 2008).
Banana fruit ripening was delayed by 8 - 12 days in the perforated and sealed polyethylene film package lining with KMnO₄ (0.5 g).

Package lining and KMnO4 significantly delayed fruit ripening, maintained quality and extended shelf-life of mango fruits.

Topics:

1. Introduction.
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6. Preparation of Horticultural Commodities for Marketing
7. Control of Pest and Diseases.
8. Special Chemical Treatments.
A number of chemicals may be applied to fruits in order to obtain a desirable post-harvest effect.

1. Chemicals that hasten ripening.
   - Ethylene and compounds that release ethylene, such as Ethrel (Ethaphon).

2. Growth retardants that inhibit growth and ripening.
   - Such as: Gibberellins (GA₃), Maleic hydrazide, 2,4,5-T.

3. Ethylene absorbents and Inhibitors.
   - Such as: KMnO₄, ‘Purafil’. 1-MCP.
1. Chemicals that hasten ripening:

- Effect of Ethylene, Acetylene, Ethrel in aqueous solution and Ethylene released from Ethrel on fruit ripening and quality of bananas, mangoes and guavas was evaluated.
Ethylene gas was 100 times more effective than acetylene in inducing fruit ripening of bananas.

Ethylene gas released from ethrel was more effective than ethrel in aqueous solution in enhancing the climacteric peak and inducing fruit ripening in bananas, mangoes and guavas.

Effect of ethylene gas released from Ethrel on banana fruit ripening

2. Growth retardants that inhibit growth and ripening.

- Effect of Gibberellins (GA₃), Maleic hydrazide, 2,4,5-T and waxing on quality and shelf-life of papayas, mangoes, guavas and limes was evaluated.
GA3 (100 & 200 ppm) and waxing on guavas reduced respiration rate, weight loss, fruit softening, peel color development, maintained quality, delayed fruit ripening and extended shelf-life 6 - 8 days.

GA3 (50 & 100 ppm) and waxing on limes reduced respiration rate, weight loss, fruit softening and degreening, retained ascorbic acid, maintained quality, delayed senescence and extended storage life.

2,4,5-T (500 & 1000 ppm) and waxing on limes reduced respiration rate, weight loss, fruit softening and degreening, retained ascorbic acid, maintained quality, delayed senescence and extended storage life.

Maleic hydrazide (250, 500 & 1000 ppm) and waxing on guavas, delayed respiratory climacteric, reduced weight loss, fruit softening and peel color development, maintained quality, delayed fruit ripening and extended shelf-life 7 – 10 days.

10 Days at 20 °C and 85 – 90 % RH

3. Ethylene absorbents and Inhibitors:

- These delay ripening and senescence because they remove the ethylene produced by the fruit or inhibit ethylene action.
- They are usually placed in close proximity to the commodity and leave no residue on it.

Examples are:

- Potassium permanganate.
- ‘Purafil’ (Potassium permanganate-impregnated in alumina or vermiculite).
- 1 – Methylcyclopropene (1-MCP).
‘Purafil’ significantly reduced respiration rate and ethylene production and delayed degreening and subsequently banana fruit ripening.

1-Methylcyclopropene (1-MCP) significantly reduced respiration rate, weight loss, fruit softening, peel color development, retained ascorbic acid, maintained quality, delayed fruit ripening and extended shelf-life of mangoes and bananas.

(Elzubeir, 2012).

15 Days at 18 °C and 85 - 90 % RH
1-MCP (250 & 500 ppb) delayed mango fruit ripening 4 - 7 days (without waxing) and 6 – 9 days (with waxing).

Control 250 ppb 1-MCP 500 ppb 1-MCP 250 ppb 1-MCP + Wax 500 ppb 1-MCP + Wax

15 Days at 18 ºC and 85 - 90 % RH

1-MCP (62.5, 125 & 250 ppb) delayed banana fruit ripening 12, 16 and 20 days, respectively, compared with the control.

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