Monitoring temperature and quality of Philippine mango exports to China
ECR study – Mango Quality Project

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Introduction

**Aim**
Assess and describe the Philippines Carabao mango conditions and quality in the export mango supply chain from Davao City, Philippines to Shanghai, China, using the Mango Quality Manual.

**Studies**

Real-world monitoring trial
- Monitor temperature and quality in the export supply chain of Carabao mango from Davao City, Philippines to Shanghai, China
- Identify causes of mango fruit rejection in the exporter’s warehouse

Simulation trial
- Evaluate the quality of different mango varieties under simulated export supply chain conditions using the Mango Quality Manual.

**Mentors & collaborators**
- Emma Ruth Bayogan, University of the Philippines Mindanao
- SPFFC, Southern Philippine Fresh Fruit Corporation
- Daryl Joyce, Department of Agriculture and Fisheries, Queensland
Methodology

Real world

- Reject bin analysis (identified causes of rejection in the exporter’s warehouse)
- Temperature monitoring (data loggers positioned in different parts of the container van)
- Quality monitoring (fruit tagged at exporter’s warehouse and positioned in different parts of the container van)

Simulation trial

- 3 mango cultivars were used
Methodology

Quality and temperature monitoring during real-world export monitoring trial

**Day 1 & Day 3**
July 24 & 26, 2018
- Export Company (SPFFC)
  Davao City, Philippines

**Day 2 & 4**
July 25 & 27, 2018
- Arrival and receiving area
  (Sorting and grading)
- Disinfection (Chlorine, HWT and VHT)

**Day 2 & 5**
July 25 & 28, 2018
- Packing and loading of cargo

**Day 6-16**
July 29-Aug 9
(12 days)
- Sea Freight Forwarder
  Davao City, Philippines to
  Shanghai, China

**Day 17**
August 9, 2018
- Quarantine
  Port of Shanghai, China

**Day 18-29**
August 10-19, 2018
- Arrival and storage in East China Normal University (ECNU) for Assessment

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**Reject Bin Analysis & Quality Assessment**

**Grading and Sorting**

100-150 ppm chlorinated water

HWT-52-55°C,
3-5 min VHT- 10 min,
46°C

**Quality Assessment**

Packing mango at 20°C
Pack into single layer in a carton box

Loading in the refrigerated container at 10°C

Shipping at 10°C,
delayed up to 10 days
Methodology

Simulation trial

Modified export supply chain used to simulate the export conditions in 3 varieties (Florida, Apple, Zambales) of mango in the Philippines.

Day 0
- Farm - harvest
  - Unload at the Wholesale market

Day 1-2
- Transport to UP Mindanao
  - Loading to container van (10°C)
    - NAOCI treatment
      - Hot water treatment
        - Cooling and Air drying
          - Packing (20°C)

Day 3-7
- Sea freight (10°C)
  - Arrival in export Consignment in the port Quarantine
    - Packing of mangoes at 20°C

Day 8-15
- Storage for Retail (20°C)
  - Cold storage at 10°C for shipment simulation from Davao City to Shanghai, China

Day 16
- Pre-treatment with 150 ppm chlorinated water for 3 min
  - HWT-52-55°C for 3 min
Results

Carabao mango quality and reject bin analysis

Scab 22.8%
Sooty mold 1.1%
Insect damage 9.0%
Ant damage 2.7%
Lenticel spotting 7.1%
Latex injury 24.8%
Yellowing/Discoloration 15.4%
Bump 4.7%
Chimera 0.3%
Undersize 2.8%
Mishapen 0.6%
Wind scar 6.2%
Growth crack 1.1%
Cuts 1.0%
Veins 0.4%

(n=934)
Results

Carabao mango quality and reject bin analysis

Mango fruit rejects (kg and %) upon receipt and packing

Percentage of Carabao mango with bumps and latex defects after packing
Temperature monitoring

Results

Temperature during nine days shipping from Davao City, Philippines to Shanghai, China

Quarantine period was reduced from 7 weeks to 1 day
Fluctuations in temperature was recorded
Temperature break was recorded on 01 August 2018 and during quarantine period
Results

Factors that can affect the cooling of produce
- Temperature difference between the product and the cooling medium
- Circulation of delivery air

![Graph showing temperature changes over time](image)

<table>
<thead>
<tr>
<th>Boxes</th>
<th>½ cool</th>
<th>¾ cool</th>
<th>7/8 cool</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temp (°C)</td>
<td>Time, h</td>
<td>Temp (°C)</td>
</tr>
<tr>
<td>Front</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td>16.4</td>
<td>3.0</td>
<td>13.2</td>
</tr>
<tr>
<td>Middle</td>
<td>16.1</td>
<td>2.0</td>
<td>13.1</td>
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<tr>
<td>Bottom</td>
<td>15.6</td>
<td>2.0</td>
<td>12.8</td>
</tr>
<tr>
<td>Centre</td>
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<tr>
<td>Top</td>
<td>16.5</td>
<td>5.5</td>
<td>13.3</td>
</tr>
<tr>
<td>Middle</td>
<td>16.4</td>
<td>4.5</td>
<td>13.2</td>
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<tr>
<td>Bottom</td>
<td>16.1</td>
<td>1.5</td>
<td>13.1</td>
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<tr>
<td>Back</td>
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<tr>
<td>Top</td>
<td>13.0</td>
<td>10</td>
<td>11.5</td>
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<tr>
<td>Middle</td>
<td>13.2</td>
<td>3</td>
<td>11.6</td>
</tr>
<tr>
<td>Bottom</td>
<td>11.8</td>
<td>2</td>
<td>10.9</td>
</tr>
</tbody>
</table>

Loading of boxes in container van
(SPFFC, Davao City, Philippines) ➔ Sea freight from Davao City, Philippines to Shanghai, China ➔ Quarantine (Shanghai, China)

Bottom-air delivery in the container van

High capacity fan
Results
Temperature monitoring

Average temperature of mango boxes positioned in different parts of the container van during export:

- Front
- Centre
- Back
- Bottom

Average 11.0±1.9°C, 96±5.6%RH of the container van during export.
## Results

### Quality monitoring

<table>
<thead>
<tr>
<th>Location</th>
<th>Davao City, Philippines</th>
<th>Shanghai, China</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Packing at SPFFC*</td>
<td>Arrival in China*</td>
</tr>
<tr>
<td>Front</td>
<td>3.4</td>
<td>8.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Centre</td>
<td>1.5</td>
<td>10.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Back</td>
<td>1.4</td>
<td>7.8&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

### Receiving in Philippines
- Excellent, slight defects, green, hard, no smell

### Packing in Philippines
- Excellent, slight defects, green, hard, no smell

### Arrival in China
- Good, slight defects, breaker, rubbery, no smell
- Fair, moderate defects, yellow good smell

% Weight loss of during shipment from Davao City to Shanghai (8.8 to 15.1% at 3 – 6 DAS)
Some defects of Carabao mango observed during shipment from the Philippines to Shanghai, China.

- Latex injury
- Lenticel spotting
- Shriveling
- Anthracnose
- Bruised
- Riciness
- Brown spot

Percentage of marketable ‘Carabao’ mango during shipment from the Philippines to China.
Results

Quality monitoring

Percentage of Carabao mango at table ripe stage placed at different locations in container van during shipment from the Philippines to China.

Percentage of fruit with anthracnose and SER during shipment from the Philippines to Shanghai, China.
## Results

### Quality monitoring

<table>
<thead>
<tr>
<th></th>
<th>Arrival in China</th>
<th>3 days from arrival in China</th>
<th>Arrival in China</th>
<th>3 days from arrival in China</th>
<th>Arrival in China</th>
<th>3 days from arrival in China</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top</strong></td>
<td><img src="image1" alt="Images" /></td>
<td><img src="image2" alt="Images" /></td>
<td><img src="image3" alt="Images" /></td>
<td><img src="image4" alt="Images" /></td>
<td><img src="image5" alt="Images" /></td>
<td><img src="image6" alt="Images" /></td>
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<tr>
<td><strong>Middle</strong></td>
<td><img src="image7" alt="Images" /></td>
<td><img src="image8" alt="Images" /></td>
<td><img src="image9" alt="Images" /></td>
<td><img src="image10" alt="Images" /></td>
<td><img src="image11" alt="Images" /></td>
<td><img src="image12" alt="Images" /></td>
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<tr>
<td><strong>Bottom</strong></td>
<td><img src="image13" alt="Images" /></td>
<td><img src="image14" alt="Images" /></td>
<td><img src="image15" alt="Images" /></td>
<td><img src="image16" alt="Images" /></td>
<td><img src="image17" alt="Images" /></td>
<td><img src="image18" alt="Images" /></td>
</tr>
<tr>
<td><strong>Front</strong></td>
<td><img src="image19" alt="Images" /></td>
<td><img src="image20" alt="Images" /></td>
<td><img src="image21" alt="Images" /></td>
<td><img src="image22" alt="Images" /></td>
<td><img src="image23" alt="Images" /></td>
<td><img src="image24" alt="Images" /></td>
</tr>
<tr>
<td><strong>Centre</strong></td>
<td><img src="image25" alt="Images" /></td>
<td><img src="image26" alt="Images" /></td>
<td><img src="image27" alt="Images" /></td>
<td><img src="image28" alt="Images" /></td>
<td><img src="image29" alt="Images" /></td>
<td><img src="image30" alt="Images" /></td>
</tr>
<tr>
<td><strong>Back</strong></td>
<td><img src="image31" alt="Images" /></td>
<td><img src="image32" alt="Images" /></td>
<td><img src="image33" alt="Images" /></td>
<td><img src="image34" alt="Images" /></td>
<td><img src="image35" alt="Images" /></td>
<td><img src="image36" alt="Images" /></td>
</tr>
</tbody>
</table>

PCI-3.7, PCI-5.6
## Results
Simulation trial

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Buying stage in the local market</th>
<th>During storage at day 23</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| ‘Florida’        | ![Image](image1.png)              | ![Image](image2.png)                                                                    | *Weight (g) - 546.1±97  
Colour - green, slight colour change to yellow at table ripe stage, some with blush  
Shape - Ovate round                                                      |
| ‘Apple’          | ![Image](image3.png)              | ![Image](image4.png)                                                                    | *Weight (g) - 546.1±81  
Colour - green to light green, colour change to yellow at table ripe stage, some without blush  
Shape - round/spheroid                                                      |
| ‘Zambales’       | ![Image](image5.png)              | ![Image](image6.png)                                                                    | *Weight - 325.9.1±30  
Colour - green, colour change to yellow at table ripe stage, few fruit show blush  
Shape - oblong                                                               |
Weight loss (A), TSS (B) and firmness (C) of Florida, Apple and Zambales mango as influenced by hot water treatment and storage conditions.
### Results Simulation trial

<table>
<thead>
<tr>
<th></th>
<th>Florida</th>
<th>Apple</th>
<th>Zambales</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 DAT</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
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<td>20 DAT</td>
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<tr>
<td>23 DAT</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
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</tr>
</tbody>
</table>

- Skin defects include scab, latex injury, lenticel spotting and decay (from 16d up to TRS)
- Apple and Zambales showed distinct changes in colour during storage from green to yellow
Conclusion

- Reject fruit in SPFFC ranged from 22 to 50%
- Common causes of rejection in the exporter’s warehouse:
  - Upon receipt: latex burn, scab, yellowing, insect damage, lenticel spotting, and bumps
  - Packing: latex injury and bumps
  - Arrival in China: latex injury, lenticel spotting, shriveling and bruise injury
- Temperature break was recorded on 01 August 2018 and during quarantine period
- The temperature difference between the product and the cooling medium can affect the cooling of produce
- Cooling period of the produce can also be affected by circulation of delivery air
- Progression of internal defects, riciness and small brown spots in the flesh in China
- Temperature inside the container van used for shipment was set at 10°C but fluctuated during transit.
- 3 cultivars showed some differences in quality such as size, colour and internal quality.
Recommendations

- Establish good relationship with the importer to be able to follow supply chain of Carabao mango in the import consignment
- Monitor pulp temperature of fruit during export
- Assess the effect of VHT on the progression of internal defects
- Determine peak season for other mango cultivars to assess more good quality fruit for evaluation including organoleptic
- Use VHT for simulation of the 3 cultivars to assess responses of fruit to treatment (undertaken in less busy months)
- Monitor a fully loaded container van.
References


- Goedhals-Gerber, L.L., Haasbroek, L., Freiboth, H. and Van Dyk, F.E., 2015. An analysis of the influence of logistics activities on the export cold chain of temperature sensitive fruit through the Port of Cape Town, J. Transport Supply Chain Mgt. 9(1).


