5th ISHS Asia Symposium on Quality Management in Postharvest Systems (AsiaPostharvest2021)

Forefront of Technology and Research for Society

Book of Abstracts & Program

December 1-2, 2021
KX Building, Bangkok, Thailand
We are pleased to welcome all of you to participate in the 5th ISHS Asia Symposium on Quality Management in Postharvest Systems (AsiaPostharvest 2021) during December 1-2, 2021 at KX - Knowledge Exchange for Innovation Building, King Mongkut’s University of Technology Thonburi, Bangkok, Thailand.

King Mongkut’s University of Technology Thonburi (KMUTT) held the first Asia Symposium on Quality Management in Postharvest Systems in February 2012. Since the first AsiaPostharvest was held in Thailand 2012, the second one was held in Laos PDR in 2014, the third one was held in Cambodia in 2015 and the fourth one was held in Korea in 2017. In 2021, the AsiaPostharvest is organized in Thailand again and this event is a series of activity to celebrate 60th Anniversary of KMUTT (2020) in collaboration with Mae Fah Luang University and Postharvest Technology Innovation Center, Ministry of Higher Education, Science, Research and Innovation, Thailand.

AsiaPostharvest 2021 brings together a forefront researchers, young scientists, and graduate students to interactively present their work and exchange ideas with senior scientists. Our call for papers attracted 59 abstract submissions from 18 different countries. The symposium program has been arranged into oral presentation session and digital poster presentation session following major topics in postharvest technology. This will be an opportunity to exchange information, engage in simulating discussions and initiate the networking with participants from Asia and from other countries. We do hope that our expert speakers and paper contributors will provide you with the most beneficial information and an up-to-date trend in postharvest technology.

The accepted full papers for the oral and poster presentations will be published in a book series of Acta Horticulturae under ISHS.

**Varit Srilaong**  
_The Symposium Convener_  
_Division of Postharvest Technology_  
_King Mongkut’s University of Technology Thonburi_  
_Bangkok 10140, Thailand_
# SYMPOSIUM COMMITTEES

## Convener
Varit Srilaong (King Mongkut’s University of Technology Thonburi, Thailand)

## Secretary General
Panida Boonyaritthongchai (King Mongkut’s University of Technology Thonburi, Thailand)

## Scientific Committee

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<tr>
<td>Anurag Sanpapao</td>
<td>Price of Songkhla University, Thailand</td>
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<tr>
<td>Apiradee Uthairatanaakit</td>
<td>King Mongkut’s University of Technology Thonburi, Thailand</td>
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<td>Bo Wen</td>
<td>Anhui Agricultural University, China</td>
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<tr>
<td>Chalermchai Wongs-Aree</td>
<td>King Mongkut’s University of Technology Thonburi, Thailand</td>
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<tr>
<td>Daisuke Hamanaka</td>
<td>Kagoshima University, Japan</td>
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<tr>
<td>Emma Ruth Bayogan</td>
<td>University of Philippines at Mindanao</td>
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<tr>
<td>John Golding</td>
<td>NSW-Department of Primary Industries, Australia</td>
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<td>Kenji Yamane</td>
<td>Utsunomiya University, Japan</td>
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<td>Khandra Fahmy</td>
<td>Andalss University, Indonesia</td>
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<td>Kim Ji Gang</td>
<td>National Institute of Horticultural and Herbal Science, Korea</td>
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<td>Krit Thirapanmethee</td>
<td>Mahidol University, Thailand</td>
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<tr>
<td>Lamul Wiset</td>
<td>Mahasarakam University, Thailand</td>
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<td>Mantana Buanong</td>
<td>King Mongkut’s University of Technology Thonburi, Thailand</td>
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<td>Masaya Kato</td>
<td>Shizuoka University, Japan</td>
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<td>Mullika T. Chomnawang</td>
<td>Mahidol University, Thailand</td>
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<td>Netnaps Kaewkhum</td>
<td>Kasetsart University, Thailand</td>
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<td>Nutthachai Pongprasert</td>
<td>King Mongkut’s University of Technology Thonburi, Thailand</td>
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<td>Panida Boonyaritthongchai</td>
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<td>Paul Holford</td>
<td>University of Western Sydney, Australia</td>
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<td>Peter Toivonen</td>
<td>Agriculture and Agri-Food Canada, Canada</td>
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<td>Phebe Ding</td>
<td>Universiti Putra Malaysia, Malaysia</td>
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<td>Pongphen Jitareerat</td>
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<td>Samak Kaewsksaeng</td>
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<td>Simmon Smir</td>
<td>Agricultural Research Organization-Volcani Center, Israel</td>
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<td>Shigeisha Okamoto</td>
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<td>Suriyan Supapvanich</td>
<td>King Mongkut’s Institute of Technology Ladkrabang, Thailand</td>
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<td>Sutthiwal Setha</td>
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<td>Yao-Chien Alex Chang</td>
<td>National Taiwan University, Taiwan</td>
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<tr>
<td>Yasushi Nakamura</td>
<td>Kyoto Prefectural University, Japan</td>
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Organizing Committee

Varit Srlaong (King Mongkut’s University of Technology Thonburi, Thailand)
Panida Boonyaritthongchai (King Mongkut’s University of Technology Thonburi, Thailand)
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Satoru Kondo (Chiba University, Japan)
Ian Warrington (Massey University, New Zealand)
Chris Hale (New Zealand)
Kohei Nakano (Gifu University, Japan)
# Symposium Program of AsiaPostharvest2021

December 1-2, 2021; KX Building, Bangkok, Thailand

## December 1, 2021 (Thailand Local Time)

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<tr>
<td>08.00-09.00</td>
<td>Registration</td>
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<tr>
<td>09.00-09.20</td>
<td>Opening Ceremony</td>
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<tr>
<td>09.20-09.40</td>
<td>ISHS Report by Prof. Dr. Christopher B. Watkins</td>
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<tr>
<td>09.40-10.00</td>
<td><strong>Invited speaker 1</strong>&lt;br&gt;Chilling injury in tropical products&lt;br&gt;Julian Heyes&lt;br&gt;<strong>School of Food and Advanced Technology, Massey University, New Zealand</strong></td>
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<tr>
<td>10.00-10.20</td>
<td><strong>Invited speaker 2</strong>&lt;br&gt;The role of postharvest technology to increase value of new varieties&lt;br&gt;Kim Ji-gang&lt;br&gt;<strong>Postharvest Research Team, National Institute of Horticultural &amp; Herbal Science (NIHHS), RDA, Korea</strong></td>
</tr>
</tbody>
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### ORAL PRESENTATION

**Chairperson:** Assoc. Prof. Dr. Chalermachai Wongs-Aree and Dr. Thamarath Pranamornkith

#### Plant Bioregulator

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<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td>10.20-10.32</td>
<td>0-01 Effect of low temperature and ABA on anthocyanin accumulation in the juice sacs of blood orange in vitro</td>
<td>Nami Kojima, Gang Ma, Lancui Zhang, Masaki Yahata and Masaya Kato</td>
</tr>
<tr>
<td>10.32-10.44</td>
<td>0-02 Effects of auxin and 1-MCP on carotenoid and chlorophyll metabolisms in postharvest Satsuma mandarin fruit</td>
<td>Kan Murakami, Gang Ma, Lancui Zhang, Masaki Yahata, Hikaru Matsumoto and Masaya Kato</td>
</tr>
<tr>
<td>10.44-10.56</td>
<td>0-03 Effects of phytohormones on coloration of Satsuma mandarin fruit during long-term storage</td>
<td>Kenta Nomura, Hayato Inaba, Gang Ma, Lancui Zhang, Masaki Yahata, Hikaru Matsumoto and Masaya Kato</td>
</tr>
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#### Supply chain

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
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<tr>
<td>10.56-11.08</td>
<td>0-04 Status of postharvest handling of fresh produce in Nepal and interventions to minimize the losses</td>
<td>Purushottam Khatiwada and Hari Bahadur K.C.</td>
</tr>
<tr>
<td>11.08-11.20</td>
<td>0-05 Temperature and quality monitoring of Philippine `Carabao´ mango exported to Shanghai, China</td>
<td>Leizel Secretaria and Emma Ruth Bayogan</td>
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<tr>
<td>11.20-11.32</td>
<td>0-06 Cultivation and supply chain environmental conditions affect vase life through alterations of stomatal functioning: An update</td>
<td>Dimitrios Fanourakis and Panayiotis A. Nektarios</td>
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#### Ornamental

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<thead>
<tr>
<th>Time</th>
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<tr>
<td>11.32-11.44</td>
<td>0-07 Relationship between pollen formation and vase life in Arabidopsis thaliana</td>
<td>Eri Hitomi and Seiji Takeda</td>
</tr>
<tr>
<td>11.44-11.56</td>
<td>0-08 Effects of chlorine releasing compound and ethylene inhibitors on vase life of 'Shimmer' cut Gerbera</td>
<td>Panupon Hongpakdee, Chanoksorn Khammali, Kesorn Kaewbua and Kannika Banyai</td>
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<tr>
<th>Time</th>
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<tr>
<td>11.56-13.00</td>
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<tr>
<td>Time</td>
<td>Session</td>
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<tr>
<td>13.00-13.20</td>
<td>Invited speaker 3</td>
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<tr>
<td>13.20-13.35</td>
<td>Keynote speaker 1</td>
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<tr>
<td>13.35-13.47</td>
<td>Physiology O-09</td>
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<tr>
<td>14.11-14.23</td>
<td>Physiology O-12</td>
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<tr>
<td>14.23-14.35</td>
<td>Physiology O-13</td>
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<tr>
<td>14.35-14.47</td>
<td>Physiology O-14</td>
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<tr>
<td>14.47-14.59</td>
<td>Physiology O-15</td>
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<tr>
<td>14.59-15.11</td>
<td>Physiology O-16</td>
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<td>15.11-15.23</td>
<td>Seed storage</td>
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<td>15.23-15.30</td>
<td>COFFEE BREAK</td>
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<td>15.30-15.45</td>
<td>DIGITAL POSTER PRESENTATION</td>
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<td>Time</td>
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<tr>
<td>15.35-15.40</td>
<td><strong>P-02</strong> Characterization of pigments accumulation in valencia orange during regreening</td>
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<td>15.40-15.45</td>
<td><strong>P-03</strong> Comparison of substrate reactivity of polyphenol oxidase and browning symptom of fresh cut mango <code>Nam Dok Mai Si-Thong</code> and <code>Nam Dok Mai No. 4</code> in vitro and in vivo</td>
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<td>15.45-15.50</td>
<td><strong>P-04</strong> Expression of differentially expressed genes associated with <code>Benny</code> valencia citrus fruit non-chilling rind pitting disorder</td>
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<td>15.50-15.55</td>
<td><strong>P-05</strong> Curcuminoids extraction from turmeric (<em>Curcuma longa</em>) using ultrasound-assisted extraction as anti-browning agents</td>
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<td>15.55-16.00</td>
<td><strong>P-06</strong> Effect of calcium ascorbate infiltration against browning in fresh cut apple</td>
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<td>16.00-16.05</td>
<td><strong>P-07</strong> Efficacy of gibberellic acid on dormancy and sprouting of small and medium G-0 potato (<em>Solanum tuberosum</em> L. <code>Granola</code>) minitubers</td>
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<tr>
<td>16.05-16.10</td>
<td><strong>P-08</strong> Efficiency of pretreatments of redox agents on delaying the pericarp browning of fresh longan during storage</td>
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<td>16.10-16.15</td>
<td><strong>P-09</strong> Improvement of ground water quality by supplementing alum on vase life solution in chrysanthemum cut flower</td>
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<td>16.15-16.20</td>
<td><strong>P-10</strong> Methyl jasmonate increases the accumulation of anthocyanins in Vanda <code>Sansai Blue</code> cut flowers</td>
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<td>16.20-16.25</td>
<td><strong>P-11</strong> Cytokinin, gibberellic acid and sugar improve the quality and extend the longevity of cut Costus flowers (<em>Costus sp.</em>)</td>
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### ASIA-POSTHARVEST2021, BANGKOK, THAILAND

#### December 2, 2021 (Thailand Local Time)

<table>
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<th>Session</th>
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<tbody>
<tr>
<td>09:00-09:20</td>
<td><strong>Invited speaker 4</strong> Exogenous application of auxin promotes carotenoid accumulation in citrus fruit after harvest</td>
</tr>
<tr>
<td></td>
<td>Masaya Kato</td>
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<tr>
<td></td>
<td><em>Faculty of Agriculture, Shizuoka University, Japan</em></td>
</tr>
<tr>
<td>09:20-09:35</td>
<td><strong>Keynote speaker 2</strong> Effect of essential oil of Yuzu (<em>Citrus junos</em>) and its aroma components on postharvest quality in strawberry fruits</td>
</tr>
<tr>
<td></td>
<td>Kenji Yamane, Ayaka Ishihara and Fumiya Ishikawa</td>
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#### ORAL PRESENTATION (Continue)

### Physical and Stress Treatments

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<tr>
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<tbody>
<tr>
<td>09:35-09:47</td>
<td><strong>O-18</strong> Effect of blue LED light irradiation on chlorophyll metabolism in the flavedo of Valencia orange in vitro</td>
</tr>
<tr>
<td></td>
<td>Haruna Mochizuki, Gang Ma, Lancui Zhang, Masaki Yahata and Masaya Kato</td>
</tr>
<tr>
<td>09:47-09:59</td>
<td><strong>O-19</strong> Effect of blue LED light irradiation on flavonoid accumulation in the flavedo of Valencia orange in vitro</td>
</tr>
<tr>
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<td>Akari Nakata, Gang Ma, Lancui Zhang, Masaki Yahata and Masaya Kato</td>
</tr>
<tr>
<td>09:59-10:11</td>
<td><strong>O-20</strong> Combined effects of hot water and eucalyptus leaf extract on the storability of Cyprus local mandarin</td>
</tr>
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<td>Ibrahim Kahramanoglu, Seyda Aldag, Kenan Umar, Murat Helvacı, Turgut Alas, Serhat Usanmaz, Mehmet Atilla Askin, Volkan Okatan and Chunpeng Wan</td>
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<tr>
<td>10:11-10:23</td>
<td><strong>O-21</strong> Suppression of lignification in postharvest asparagus by hot water treatment</td>
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<td>Wai Wai Lwin, Nuttachai Pongprasert and Varit Srilaong</td>
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<tr>
<td>10:23-10:35</td>
<td><strong>O-22</strong> Comparison of hot water and UV-C treatments in controlling postharvest disease and maintaining postharvest quality of ‘Nam Dok Mai Si Thong’ mango</td>
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<td>Moe Moe Zaw, Sutthiwat Setha and Matchima Naradisorn</td>
</tr>
<tr>
<td>10:35-10:47</td>
<td><strong>COFFEE BREAK</strong></td>
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<tr>
<td>10:47-10:59</td>
<td><strong>O-23</strong> Quality characteristics of ‘Carabao’ mango as affected by preharvest bagging at two fruit maturity stages followed by hot water treatment</td>
</tr>
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<td></td>
<td>Leizel Secretaria, Michael Angela Urguiola, Emma Ruth Bayogan, Rowina Esconde, Stefano de Faveri and Peter Johnson</td>
</tr>
<tr>
<td>10:59-11:11</td>
<td><strong>O-24</strong> Improving postharvest quality of tomato with the application of electric field treatment</td>
</tr>
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<td>Siti Aisyah Abdullah, Daisuke Hamanaka, Yuko Hamaguchi and Riichiro Yoshida</td>
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### Storage

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<tr>
<td>11:11-11:23</td>
<td><strong>O-25</strong> Synergistic effect of pre-harvest treatments on storability of date palm fruit (<em>Phoenix dactylifera</em> L. cv. Khenizi)</td>
</tr>
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<td>Zienab Ahmed and Navjot Kaur</td>
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<tr>
<td>11:23-11:35</td>
<td><strong>O-26</strong> A coating formula developed from Neolitsea cassia leaf extract extends storage life of lime (<em>Citrus aurantifolia</em>) fruit</td>
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<td>Sandunika Kithmini, Harindra Champa, Sisira Silva and Nilanthi Wijewardhana</td>
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<tr>
<td>11:35-11:47</td>
<td><strong>O-27</strong> Comparison of storage method and packaging material on physicochemical of fresh-cut melons (<em>Cucumis Melo</em> L.) during distribution</td>
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<td>Satria Bhirawa Anoraga, Mohammad Affan Fajar Falah, Iman Sabarisman, Herliana Valent Putri, Novia Rizka Shofiyani and Nadilla Shintya Kusuma Wardhani</td>
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<td>Time</td>
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</table>
| 11.47-11.59 | O-28 Effects of coating and temperature during storage on antioxidants of mango fruit cv. Nam Dok Mai Sithong  
Supatchaya Nampila and Supat Isarangkool Na Ayutthaya |                                                                                             |
| 11.59-13.00 | LUNCH                                                                                      |                                                                                             |
| Chairperson: Asst. Prof. Dr. Phunsiri Suthiluk and Asst. Prof. Dr. Wirongrong Tongdeesootorn |                                                                                             |
| 13.00-13.20 | Invited speaker 5 Function of pectinesterase on fruit softening  
Wen Bo  
School of Horticulture, Anhui Agricultural University, China |                                                                                             |
| 13.20-13.32 | O-29 High oxygen pretreatment affects stored quality and antioxidant capacity of strawberry (Fragaria × ananassa Duch.) during cold storage  
Peeraphat Prempee, Sutthiwal Setha and Thamarath Pranamornkith |                                                                                             |
| 13.32-13.44 | O-30 Effect of gaseous ozone treatment on mancozeb fungicide residue degradation and quality of ‘Jinda’ chilli (Capsicum annuum L.) fruit during storage  
Natthapong Janhom and Kanda Wangchrai |                                                                                             |
| 13.44-13.56 | O-31 Usages of Thai basil oil vapour in controlling Colletotrichum sp. in post-harvest storage of mangoes var. Nam Dok-Mai  
Tibet Tangpao, Wilawan Kumpoun, Ratchadawan Cheewangkoon, Patchareeya Withee and Sarana Rose Sommano |                                                                                             |
| 13.56-14.08 | O-32 Impact of bio-control management on post-harvest characterization of Chinese flowering cabbage  
Puping Ta-oun, Kwanruedee Suwakrai, Panupon Hongpakdee and Prakaijan Nimkingrat |                                                                                             |
| 14.08-14.20 | O-33 Efficacy of citral vapour in controlling postharvest green mold decay of citrus fruit  
Mohammad M. Rahman, Ronald B.H. Wills, Michael C. Bowyer, John B. Golding,  
Timothy Kirkman and Penta Pristijono |                                                                                             |
| 14.20-14.25 | P-12 Effect of oxalic acid on quality parameters of basil leaves  
Intira Lichanporn, Palida Tunganurat, Nunchanok Nanthachai and Purin Akkarakultron |                                                                                             |
| 14.25-14.30 | P-13 Effect of short-term anoxia on chlorophyll and sensory attributes of carambola fruit cv. See-Thong  
Prakaidao Yingsanga and Chairat Techavuthiporn |                                                                                             |
| 14.30-14.35 | P-14 Development of electrospun nanofibers containing methyl jasmonate for applying in postharvest fruit and vegetable  
Panda Boonyaritthongchai, Chaiyaporn Kebnong, Pathompong Penchaiya, Varit Srilong, Suriyan Supapvanich and Racha Tepsorn |                                                                                             |
| 14.35-14.40 | P-15 Whey protein incorporated with olive oil as novel edible coating for fresh-cut pineapple  
Apiradee Uthairatanakij, Natta Laohakunjit, Pongphen Jitareerat and Yohannes Wote |                                                                                             |
| 14.40-14.45 | P-16 Changing of antioxidant activity of butterfly pea flower in modified atmosphere packaging  
Niramon Suntipabivivattana |                                                                                             |
| 14.45-15.00 | COFFEE BREAK                                                             |                                                                                             |

**DIGITAL POSTER PRESENTATION (Continue)**

<table>
<thead>
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#### Plant Bioregulator

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Kanchana Thinnabut, Ubon Tangkawanit and Panupon Hongpakdee
Chilling injury in tropical products

Julian Heyes
School of Food and Advanced Technology, Massey University, Palmerston North, New Zealand 4442

Abstract
Tropical fruit and vegetables are generally restricted in postharvest trade because of a major disorder that limits their storage potential. This is chilling injury (CI) that arises from an inability to adjust their metabolism to temperatures below about 15 °C. The cell membrane seems to be the first part of the plant cell that is disturbed by low temperatures, with its fluidity compromised by localised lipid gelation. This disturbs calcium compartmentation and restricts protein mobility, ultimately causing oxidative damage and cell death. In practice, CI is particularly problematic because (a) it may not be visible when products are first removed from cool storage and (b) symptoms are often most severe internally. Together these mean that the disorder may not be detectable until after purchase, giving rise to strong consumer negativity. In this address I describe technologies that show promise for reducing CI in specific tropical products, such as low temperature conditioning, at-harvest treatments inducing mild stress ('hormetic' treatments), and intermittent warming. The use of safe chemical treatments such as methyl jasmonate has also been found to be beneficial for some products. Growing evidence indicates specific transcription factors such as C-repeat binding factors (CBFs) may confer improved chilling tolerance when upregulated, suggesting that gene editing may hold potential for delivering improved varieties with reduced sensitivity to CI.

Keywords: CBF, fruit, postharvest, reactive oxygen species, treatments, vegetables
Invited Speaker 2

The role of postharvest technology to increase value of new varieties

Kim Ji-gang
Department of Horticultural Crop Research, National Institute of Horticultural and Herbal Science, Rural Development Administration, Wanju, Republic of Korea

Abstract
The proportion of horticultural industry in Korea’s agriculture production has increased over the last decade. In general, year-round production of horticultural crops is available with expansion of protected cultivation and use of improved varieties. The consumption of fruits and vegetables per capita has increased and consumer preferences have changed markedly with growing interest in convenience, taste, health, etc. With changing climatic conditions horticultural crops are vulnerable to abnormal weather. Therefore, there is a need for developing new varieties to respond consumption trends and overcome climate change. Breeding of horticultural crops is one of core research area not only in Korea but also in other Asian countries. Research institutes dealing with horticultural crops develop new varieties every year from various vegetables, fruits, and flowers. However, many new varieties are unable to enter the market because they are not distributed properly after harvest. These varieties can be consumed more and their value can be increased depending on the post-harvest management. In Korea, varieties of strawberry, Kimchi cabbage, pear, persimmon, and chrysanthemum, which are promising crops for export have been developed. Postharvest technology suitable for vessel export was developed and disseminated to export farm area. In the case of strawberry, a device that treats CO2 and ClO2 at the same time and packaging container suitable for Keumsil variety was developed. By applying the technology to the variety, it contributed to selling at higher price than current major export variety. Since Kimchi cabbage has different characteristics depending on the season, we have developed export handling manuals suitable for each season and disseminated to the industry. Plumcot varieties have a very short shelf-life, but the fruits were not harvested at the right time for distribution. The optimum picking time for various distribution markets and packaging for each variety have been applied to promote sales at higher price. Through research on post-harvest physiology of new varieties, Arisu apple has less browning and the variety can be used for fresh-cut fruits that has increased rapidly in Korea. The new kiwi varieties with yellow and red flesh have different postharvest characteristics such as ripening and storage condition. Ethylene generating pad was developed and applied it appropriately for each variety. Phalaenopsis is exported as seedlings, and it takes a long time to transport from Korea to FL, USA. Pre and postharvest technology and new transportation method are being applied to increase flowering rate and prevent decay of the seedling. These postharvest technologies play a role in entering new varieties into the market. There is a growing demand to develop varieties suitable for fresh-cut produce. One of the challenges is to reduce labor during the postharvest handling, especially grape and tomato used for fresh-cut fruits. Therefore, participation of postharvest technologist is strongly required in evaluating promising varieties and improving marketability. Breeder and post-harvest technologist need continuous communication and cooperation to disseminate the developed varieties and increase the value of the crops.

Keywords: breeding, consumption, distribution, horticultural crops, marketability, new varieties, postharvest technology
Invited Speaker 3

Application of electric field in food supply chain

Daisuke Hamanaka
Faculty of Agriculture, Kagoshima University, Japan

Abstract
In the preservation process of fresh produce, in addition to control the temperature and humidity with optimum condition for each individual commodity, it is necessary to control environmental gas concentration and consider the influence of light exposure during storage. These technologies have been widely used because they are significantly effective in shelf-life extension, economically useful without special manipulation. However, when considering the actual situation of cold-chain of fresh fruits and vegetables, it is very difficult to prepare an ideal environmental condition during transportation. In general, storage environment, especially temperature, is unstable because the ideal cold-chain is often broken due to the workers handling such as door opening/closing, loading/unloading of storage room and trucks. Even if the environmental factors such as temperature and humidity are unstable during storage and transportation, higher freshness and quality is expected to be maintained when some technologies, which reduces stresses on fresh produce and suppress physiological activity, can be developed. From these background of fresh produce during postharvest stage, we investigated the shelf-life extension of fresh commodities by electric field (EF) technology. EF is defined as the space where electric force generated by electric charge works, and the Asakawa effect is widely known as a place where chemical reactions are promoted (Asakawa, 1976). In some previous studies, researchers reported that EF was effective not only in the preservation of fresh agricultural produce, but the quality maintenance during the freezing and thawing of fish and animal meat. In addition, the dehydration of some agricultural produce was accelerated by EF treatment. However, the obtained data reported previous researchers were not enough for the useful application of EF technology for the shelf-life extension of fresh produce. EF treatment is expected to be widely used for fruit and vegetable preservation in the future because it is environmentally friendly and easy to control, as there is no residue. In fact, it has been introduced into marine surface transporting containers and facilities for long-term storage. However, the mechanism of the effect of EF on fresh produce is still unclear. Therefore, here in this lecture, I would like to report some of the previous application of EF treatment and data from experiments conducted in our laboratory.

Keywords: electric field, shelf-life, quality, physiological response
Invited Speaker 4

Exogenous application of auxin promotes carotenoid accumulation in citrus fruit after harvest

Masaya Kato
Faculty of Agriculture, Shizuoka University, Japan

Abstract

Carotenoids are a group of tetraterpene pigments widely distributed in nature, and responsible for red, orange, and yellow colors of fruit and vegetables. Citrus fruit is a rich source of carotenoid. The carotenoid content and composition are important indexes of citrus fruit quality. In the present study, the effects of postharvest treatment of 1-naphthaleneacetic acid (NAA) on carotenoid biosynthesis were investigated in the flavedo of citrus fruit. The results showed that postharvest treatment of NAA effectively improved carotenoid accumulation in the flavedo in a concentration-dependent manner. Along with the increases of NAA concentration, there was a gradual increase of carotenoids contents in the flavedo of citrus fruit. In the treatment of 500 μM NAA, the contents of β-carotene, β-cryptoxanthin, lutein, all-trans-violaxanthin, and 9-cis-violaxanthin were significantly increased, and the expression of carotenoid biosynthetic genes (CitPSY, CitZDS, CitLCYb1, CitLCYb2, CitLCYe, CitHYb, CitHYe, and CitZEP) was simultaneously up-regulated in the flavedo of citrus fruit. In addition, we found that 15°C was an optimal temperature for the storage of the NAA-treated fruit after harvest. Moreover, the combination of NAA treatment with red LED light could enhance the positive effects of NAA on carotenoid accumulation in citrus fruit after harvest. In this study, to improve the coloration of GA and PDJ-treated fruit, we treated the fruit with 500 μM NAA after harvest. The results suggested that postharvest treatment of NAA has a great potential in improving the poor coloration of GA and PDJ-treated fruit through the induction of carotenoid biosynthesis in the flavedo. The results presented in this study indicated that NAA is a positive regulator of carotenoid biosynthesis in citrus fruit, and the postharvest application of NAA contributed to improving the quality and commercial values of citrus fruit.

Keywords: auxin, Carotenoid, Citrus, Gene expression, NAA, Red LED light
Invited Speaker 5

Function of pectinesterase on fruit softening

Wen Bo
School of Horticulture, Anhui Agricultural University, China

Abstract
Postharvest storage is largely limited by fruit softening which is mainly caused by cell wall degradation. Pectin methylesterase (PME) (EC 3.1.1.11) is a major hydrolase responsible for pectin deesterification in plant cell wall, however its role in fruit softening is largely unknown. A genome-wide analysis of the PME gene family in tomato (Solanum lycopersicum) was performed and 57 non-redundant PME genes were identified. Further analysis suggested that both segmental and tandem duplication were contributed to the expansion of the PME gene family. Gene expression pattern analysis suggested that two previously isolated PME genes (Pmeu1 and Pme2 ) and three newly identified candidate genes (Solyc03g083360, Solyc07g071600, and Solyc12g098340) may have functions during fruit ripening and are regulated by ethylene. In this study, Pmeu1 and Pme2 were characterized by antisense suppression in tomato. Transgenic tomato plants showed reduced PE activity levels in both Pmeu1as and Pme2 as fruit to around 74% and 24% of that found in wild-type plants, respectively. Silencing of Pme2 have little effect on fruit texture during fruit ripening. However, an enhancement to the rate of softening was observe in Pmeu1as fruit during ripening. Immunoassays suggested that the tomato Pmeu1 and Pme2 changed pectin structure at cell junctions, which could be associated with fruit softening.

Keywords: tomato, pectin methylesterase genes, cell wall, fruit softening, ethylene, functional divergence
Keynote Speaker 1

Trendy supplements: Modern delivery methods of natural products to consumers

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Abstract

Natural products have been consumed for generations and have become the backbone of herbal and traditional medical practitioners. Almost in every community, you will find unique concoctions for nearly every medical condition. The inclusion of these remedies is gaining popularity again as research begins to peel the layers of secrecy and reveal the true potential that has been locked away. With revelation from high antioxidant activity to strong anti-cancer properties, traditionally consumed plants are beginning to make headway again in the modern world. However, while the trend toward using traditional and herbal medicines has developed nowadays, there is a growing concern regarding them being polluted with heavy metals, as shown in recent studies. It is now becoming clear that there is a need to characterise and study individual plant species’ bioactivities and determine how these characteristics are modified when preparing blends or supplements to be used as a delivery option. This paper presents two popularly consumed plant Moringa oleifera and Piper betle that has been extensively characterised and produced in capsules to be delivered as a health supplement.

Keywords: Natural product, Moringa oleifera, Piper betle
Effect of essential oil of Yuzu (Citrus junos) and its aroma components on postharvest quality in strawberry fruits

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Abstract
Strawberry fruits are so soft and susceptible to mold that they have a short shelf life. In this study, treatments of essential oil of Yuzu (Citrus junos Sieb. ex Tanaka) and its volatile components was examined in strawberry fruits. Fruits were put into packs and kept at 5 °C in a refrigerator. A filter paper treated with Yuzu essential oil, α-Pinene, γ-Terpinene, or Limonene was sandwiched between the pack and the cushioning material to hold fruits. Yuzu oil and aroma components showed antibacterial activity against black bread mold (Rhizopus stolonifera) and gray mold (Botrytis cinerea), and also increased and maintained fruit hardness, and consequently extended the storage period of strawberry fruits. The sugar acid ratio tended to be higher in the Yuzu essential oil-treated group than in the control group. Although Yuzu essential oil and the aroma components treatment could affect the taste and flavor, it was suggested that these treatments are effective in maintaining the appearance and reducing the loss in long-distance transportation by suppressing mold and reducing physical damage.

Keywords: Hardiness, mold, postharvest quality, shelf life, sugar acid ratio
Effect of low temperature and ABA on anthocyanin accumulation in the juice sacs of blood orange \textit{in vitro}

Nami Kojima*, Gang Ma, Lancui Zhang, Masaki Yahata and Masaya Kato
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Abstract
Anthocyanins are pigments that play important roles in the prevention and therapy of eye diseases. In plants, anthocyanin accumulation is affected by the environmental conditions, such as temperature and light irradiation. Blood oranges are rare citrus varieties that accumulate high amounts of anthocyanins in the juice sacs. To date, the research on the regulation of anthocyanin accumulation in citrus fruit is still limited. In this study, to elucidate the mechanisms of anthocyanin biosynthesis in blood oranges, the effects of low temperature (10°C) and ABA treatment on anthocyanin accumulation were investigated in the juice sacs of two blood orange varieties (‘Moro’ and ‘Tarocco’) \textit{in vitro}. The results showed that low temperature was effective for inducing anthocyanin biosynthesis in the juice sacs of ‘Moro’ and ‘Tarocco’ \textit{in vitro}. At the low temperature, the expression of anthocyanin biosynthetic genes was significantly up-regulated, and the anthocyanins contents in the juice sacs cultured at 10°C was much higher than those in the control (cultured at 20°C). In contrast to the low temperature treatment, ABA treatment did not significantly affect anthocyanin accumulation in the juice sacs of ‘Moro’ and ‘Tarocco’ \textit{in vitro}. The anthocyanins contents and expression levels of the anthocyanin biosynthetic genes in the ABA treatment were similar to those of the control. The results presented in this study suggested that low temperature was a key factor for inducing anthocyanin biosynthesis in blood oranges.

Keywords: Abscisic acid, anthocyanin, blood orange, low temperature
Effects of auxin and 1-MCP on carotenoid and chlorophyll metabolisms in postharvest Satsuma mandarin fruit

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Abstract
Carotenoid and chlorophyll are important pigments that are responsible for the color and quality of citrus fruit. In citrus fruit, the peel color turns from green to orange during the ripening process along with the accumulation of carotenoids and sharp decreases of chlorophylls. In our previous studies, it was reported that plant hormone auxin (NAA) treatment was effective to accelerate the color changes in the flavedo of Satsuma mandarin (Citrus unshiu Marc.) after harvest. To date, however, the mechanisms that NAA improved the coloration in citrus fruit is still unclear. In the present study, the effects of combined treatment of NAA and 1-MCP on carotenoid and chlorophyll metabolisms were investigated in the flavedo of Satsuma mandarin after harvest. The results showed that the combined treatment of NAA and 1-MCP delayed the coloration in the flavedos as compared with the NAA treatment alone. On the sixth day after harvest, the contents of the major carotenoids, 9-cis-violaxanthin and β-cryptoxanthin, in the combined treatment of NAA and 1-MCP were lower than those in the NAA treatment. In contrast, the chlorophylls contents in the combined treatment of NAA and 1-MCP were much higher than those in the NAA treatment. Gene expression results showed that the changes in carotenoid and chlorophyll accumulation in the combined NAA and 1-MCP treatment were highly regulated at the transcriptional level. These results indicated that the improvement of coloration by NAA treatment might be through regulation of endogenous ethylene in citrus fruit.

Keywords: Citrus, carotenoid, chlorophyll, auxin, 1-MCP
Effects of Phytohormones on Coloration of Satsuma Mandarin Fruit during Long-term Storage

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Abstract
Carotenoids are natural pigments, which exhibit red, yellow, and orange colors. Citrus fruit is a rich source of carotenoids; the massive accumulation of carotenoids leads to an attractive color of the flavedo and juice sacs. In citrus, the carotenoid content and composition are important indexes for the nutritional and commercial values of mature fruit. In the present study, to improve the coloration of citrus fruit, the effects of auxin (NAA) and abscisic acid (ABA) on carotenoid accumulation were investigated in the flavedos of Satsuma mandarin ‘Aoshima unshiu’ (Citrus unshiu Marcow.) during long-term storage period. The results showed that the ABA treatment induced carotenoid accumulation in the 4th and 8th week after harvest. In the NAA treatment, carotenoids contents, especially β-cryptoxanthin and lutein, were significantly increased from the 8th week after harvest, and the total carotenoid in the NAA treatment was approximately 1.4 times higher than that of the control in the 12th week after harvest. Gene expression results showed that the expression of CitLCYb2 and CitHYb was simultaneously up-regulated by NAA and ABA treatments. The higher expression levels of the two key carotenoid biosynthetic genes were well consistent with the enhanced carotenoids contents in the NAA and ABA treatments during the long-term storage. These results suggested that NAA and ABA treatments were effective for inducing carotenoid accumulation and improving coloration of citrus fruit during long-term storage.

Keywords: Aoshima unshiu, carotenoid, chlorophyll, phytohormones
Status of postharvest handling of fresh produces in Nepal and interventions to minimize the losses

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Abstract
Nepal enjoys tropical, sub-tropical and temperate agro-ecologies in narrow span resulting cultivation of more than 50 vegetables and 21 fruit species in different seasons of a year. Significance of postharvest management of fresh produces has increased in the recent decades due to development of new commercial hubs in interior parts, long distance transport to the urban areas, rapid urbanization, increasing purchasing power and change in food habits. Though the country has not gone through the systematic postharvest loss assessment, 15-30% and 20-35% losses after harvest is guesstimated for vegetables and fruit, respectively. Nepal has been paying due attention on agriculture commercialization and value chain approach. However, postharvest management aspect is often neglected. This paper analyses the existing postharvest handling practices in different marketing channels operating for fresh produces. The low level of knowledge and skills on postharvest operations among all supply chain actors ensue high physical and physiological losses along with higher transportation cost resulting deteriorated quality of the produces with about four-folds higher consumer price than that of farm-gate price. Against this backdrop, awareness on benefit realization of postharvest loss reduction, enhancement of low-cost technologies adoption, interventions on newly emerged marketing system (e-commerce and superstores), issues of food safety, promotion of value chain thinking among the actors, and strengthening the institutional capacities have been suggested as the immediate actions and prioritized interventions with policy instruments are recommended upon execution of nation-wide systematic postharvest loss assessment of fresh produces.

Keywords: Fresh produces, interventions, Nepal, postharvest handling, postharvest loss
Temperature and quality monitoring of Philippine `Carabao´ mango exported to Shanghai, China

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Abstract

The temperature in the refrigerated container, and in boxes of ‘Carabao’ mangoes exported from Davao City, Philippines to Shanghai, China in July 2018 were monitored. Data loggers were positioned in boxes in the bottom, middle and top layers located in front, center and back of the container. Samples for quality assessment were likewise taken from different locations in the container. The average temperature and relative humidity (RH) recorded were 11.0±1.9°C and 96±5.6%RH, respectively. The minimum temperature recorded in boxes of mangoes during shipment was 9.5 °C, while the maximum temperature was 22.9 °C (recorded one hour from loading). The temperature was lower in the front of the container during shipment. Temperature breaks were recorded during shipment and the quarantine period. Variations in quality were observed in fruit positioned at various locations in the container which was attributed to several delivery times over a period of 73 h in the exporter’s warehouse. Fruit were shipped for 9 d including a day of delay. Mangoes at the back of the container van were delivered later which resulted in better quality fruit. Higher temperatures recorded in the center of the container tended to affect fruit quality. Fruit at the bottom cooled faster and exhibited better visual quality, lower weight loss, a higher percentage of marketable fruit, and a lower percentage of fruit with diseases. Latex injury, bruising, lenticel spotting, shriveling, anthracnose, stem-end rot, and internal defects such ‘riciness’ and brown spots were evident during storage in China.

Keywords: ‘Carabao’ mango, export, quality, temperature
Cultivation and supply chain environmental conditions affect vase life through alterations of stomatal functioning: An update

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Abstract
Genotype, growth environment and postharvest conditions all interact to determine cut flower longevity. Inherent variability in each of these factors, in combination with the complex interactions set vase life as a highly unpredictable property. Avenues to increase the degree of certainty that the cut flower will last a minimum length of time (concept of vase life guarantee) are, therefore, highly needed. Limited stomatal control of transpiration leads to early vase life termination associated with lethal wilting symptoms. In this survey, the role of cultivation environment on determining stomatal functioning is reviewed together with recent evidence on the effect of supply chain conditions. Elevated ozone concentration (60–80 ppb), high relative air humidity (RH ≥ 85%), low air velocity, and continuous light during cultivation disturb stomatal functioning. The effect of high RH in combination with continuous light is detrimental. Notably, the high RH-induced adverse effect can be mitigated by several cultivation techniques. Increased light intensity, monochromatic red light and low RH (40%) during cultivation stimulate stomatal functioning. Mid-term (4–7 d) exposure to high RH, and long-term storage (28 d) at low temperature (0.5°C) during the supply chain attenuate stomatal functioning depending on the species. By registering relevant climatic data during both preharvest and postharvest periods, an indication of leaf stomatal functioning may be deduced. Based on this, phenotype sorting in the market will be assisted by revealing batches with low potential vase life.

Keywords: Keeping quality, preharvest, postharvest, stomatal closing ability, transpiration
Relationship between pollen formation and vase life in Arabidopsis thaliana

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Abstract
In many plants, pollination accelerates the aging of petals, leading the translocation of nutrients for seed generation. This helps plants to save energy, although it shortens the vase life of cut flowers. To prolong the vase life, some flowers such as lilies require anther removal at flower shops but it increases the labor and loses the value of floral morphology. In order to generate a variety with longer vase life without affecting the floral morphology, we focused on pollen genes and examined the pollen-defective mutants in Arabidopsis thaliana. The aborted microspores (ams) and male sterile1 (ms1) mutants of Arabidopsis form stamens including anthers but no pollens in the anthers, resulting in male sterility. We found that vase life of cut flowers was about one week longer in the mutants than wild type. Moreover, the cut flower of mutants grew by 30 to 40% more than wild type. These results suggest that pollen defects prolong the vase life without affecting the floral morphology. We are investigating the expression of senescence and ethylene genes in pollen mutants to clarify the relationship between pollen-forming genes and vase life. Our findings lead to the novel technique to generate the new varieties with improved vase life.

Keywords: Pollen, vase life, Arabidopsis
Effects of chlorine releasing compound and ethylene inhibitors on vase life of 'Shimmer' cut gerbera

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Abstract
Gerbera is one of the most important cut flowers in world's market, ranked the top ten of cut flowers in Netherland, USA and Japan. Dassada blossom company in Thailand try to launch this 'Shimmer' light pink gerbera species to Japan, but they also face some problem as deterioration of flower which might cause by xylem clogging and accumulated ethylene in shipping process. The study aimed to extend vase life of Gerbera jamesonii var. ‘Shimmer’ by conducted the experiment in 3 × 2 Factorial in Completely Randomized Design (CRD) with different concentration of calcium hypochlorite; Ca(ClO)₂ (0, 50 and 100 ppm) for prevented microbial occlusions and 1-MCP (smoked and non-smoked) for ethylene removal. It was found that 50 ppm of Ca(ClO)₂ in holding solution treatment increase the rate of water uptake and prolong vase life of gerbera by delay flower head deterioration. Fumigated flower with 1-MCP increase both waters up take and % initial flower fresh weight (FW) change, led the plant had delay flower head deteriorate score. Nevertheless, it was found an interaction between Ca(ClO)₂ and 1-MCP treatment by 50 ppm of Ca(ClO)₂ and fumigated 1-MCP gave the best result in water up take rate, % initial flower FW change and delay deterioration score. This procedure had effective for extend vase life of ‘Shimmer’ gerbera.

Keywords: Barberton Daisy, prolong vase life, calcium hypochlorite, 1-MCP, cut flower
Accumulation of β-Citraurin and expression of carotenoid cleavage dioxygenase4 gene in citrus fruit during maturation

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Abstract

β-Citraurin is a red pigment that is specifically accumulated in flavedos of some citrus varieties. The citrus varieties accumulating β-citraurin are considered more attractive because of their red-orange color. Carotenoid Cleavage Dioxygenase4 (CitCCD4) is a key gene involved in the biosynthesis of β-citraurin in the flavedo of citrus fruit. In this study, to elucidate the mechanism of the accumulation of β-citraurin in citrus fruit, the changes in the carotenoids contents and the expression of CitCCD4 were investigated in the flavedos of four citrus varieties, ‘Hayashi-unshiu’ (Citrus unshiu Marc.), ‘Dobashibeni-unshiu’ (Citrus unshiu Marc.), ‘Clementine Vita’ (Citrus clementina hort. ex Tanaka), and ‘Akemi’ (‘Kiyomi’ tangor × ‘Seminole’ tangelo) during maturation. The results showed that ‘Dobashibeni-unshiu’, ‘Clementine Vita’, and ‘Akemi’ accumulated high amount of β-citraurin in the flavedos during maturation. In contrast, β-citraurin was undetectable in the flavedo of ‘Hayashi-unshiu’ throughout the maturation process. In the flavedos of ‘Dobashibeni-unshiu’, ‘Clementine Vita’, and ‘Akemi’, β-citraurin content increased rapidly from October. Among the three citrus varieties, ‘Clementine Vita’ accumulated the highest amount of β-citraurin in the flavedo, followed by ‘Dobashibeni-unshiu’ and ‘Akemi’. The gene expression results showed that the expression of CitCCD4 increased significantly with a peak in November in the flavedo of ‘Dobashibeni-unshiu’, ‘Clementine Vita’, and ‘Akemi’; however, it remained at a low level in the flavedo of ‘Hayashi-unshiu’ during maturation. In November, the expression level of CitCCD4 in the flavedo of ‘Clementine Vita’ was the highest among the three citrus varieties, followed by ‘Dobashibeni-unshiu’ and ‘Akemi’. The changes in the expression of CitCCD4 were well consistent with the accumulation of β-citraurin in the flavedos of ‘Dobashibeni-unshiu’, ‘Clementine Vita’, and ‘Akemi’. These results suggested that CitCCD4 was a key gene regulating β-citraurin accumulation in the flavedos of citrus fruit.

Keywords: β-Citraurin, carotenoid, citrus, gene expression
Herbal based ripening stimulant accelerated the ripening of banana (Musa acuminata var. Embul)

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Abstract
Efficacy of pellets developed from leaf powder mixture (LPM) of kappetiya (Croton aromaticus) and bilin (Averrhoa bilimbi) in stimulating ripening of banana (Musa acuminata var. Embul) was investigated. The pellet was prepared using 0.75 g of bilin, 0.75 g of kappetiya (1:1) leaf powders and 1.5 g of grated beeswax. Banana at commercial maturity (mature green, ¾th fullness, TSS % 8.6±0.2, TA % 0.54±0.01) was harvested and clustered to have 3-4 fingers per cluster. Approximately one kg of banana clusters was treated with 10 (T1), 20 (T2) and 30 pellets (T3) for 48 h in corrugated fiber board boxes (CFB). As the fourth treatment (T4), one kg of banana clusters was placed in a ripening chamber and exposed to the smoke generated by burning of one pellet for 24 h. As the control, one kg of banana clusters was kept in a CFB box for 48 h without treatment. Physicochemical properties (peel color, pulp firmness, TSS, TA, TSS/TA ratio, visual quality rating, disease development) and organoleptic attributes were evaluated 0, 2, 4 and 6 days. Emanations of LPM and its smoke were analyzed by gas chromatography. Ripening was significantly hastened by banana clusters treated with the smoke generated by burning one pellet followed by banana kept with 30 pellets on the contrary to other two treatments (10 & 20 pellets) and the control. Higher ranks for sensory attributes were obtained by bananas exposed to 30 pellets. A significant concentration of ethylene (105.7 ppm) was present in the smoke obtained from burning of 1 pellet and no acetylene or carbon monoxide were detected. In conclusion, exposure of 1 kg of banana var. Embul to 30 pellets of the developed LPM accelerated ripening with optimum sensory attributes in contrast to the control and other three treatments examined.

Keywords: Averrhoa bilimbi, Croton aromaticus, ethylene, firmness, maturity, total soluble solids, titratable acidity
Characterization of β-cryptoxanthin esters accumulation and carotenoid biosynthetic genes expression during citrus fruit maturation

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Abstract
Xanthophylls are a class of carotenoids that play important roles in plant and human health. In citrus fruit, most of the xanthophylls are esterified with fatty acids. In the previous study, we reported that β-cryptoxanthin was mainly esterified with lauric acid, myristic acid, and palmitic acid in two Satsuma mandarin varieties, ‘Miyagawa-wase’ and ‘Yamashitabeni-wase’. In this study, the changes in the β-cryptoxanthin accumulation and the expression of carotenoid biosynthetic genes were investigated in ‘Ponkan’ (Citrus reticulata Blanco), ‘Dancy tangerine’ (Citrus tangerina hort. ex Tanaka), and a novel citrus cultivar, ‘Citrus Nou No. 6’ (Citrus nobilis × Citrus kisyu) during the fruit maturation. The results showed that β-cryptoxanthin accumulated gradually during the fruit maturation, and β-cryptoxanthin esters accounted for about 90% of total β-cryptoxanthin in the flavedo and juice sacs of the three citrus varieties. Gene expression results showed that the expression of carotenoid biosynthetic genes increased during the maturation, which was consistent with the accumulation of β-cryptoxanthin. In addition, the expression of xanthophyll esterase (CitXES) increased rapidly at the early stage of maturation. The increase in the expression of CitXES appeared earlier than that of carotenoid biosynthetic genes and β-cryptoxanthin accumulation. These results indicated that the increase in the expression of CitXES at the early stage might lead β-cryptoxanthin to be esterified immaterially after its biosynthesis during the fruit maturation.

Keywords: Carotenoid, Citrus, Xanthophyll esterase (XES)
Effects of SNP and cPTIO on oxidative membrane damage and pericarp browning of harvested longan fruit

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Abstract
Nitric oxide (NO) can generate other reactive nitrogen species (RNS) and induce progressive cellular damage and associated disorders due to oxidative stress. Here, we investigated the effects of sodium nitroprusside (SNP; NO donor) or 2-(4-carboxyphenyl)-4,4,5,5-tetramethylimidazoline-1-oxyl-3-oxide (cPTIO; NO scavenger) on reactive oxygen species (ROS) contents, oxidative membrane damage and pericarp browning of longan during storage. Longan fruit were dipped in distilled water (control), SNP (50 and 100 mM) or cPTIO (100 and 500 µM) for 10 min, then stored at 25±1°C for 7 days. SNP-treated fruit exhibited higher ROS contents (superoxide radical, hydrogen peroxide and hydroxyl radical), oxidative membrane damage (malondialdehyde, protein carbonyl and electrolyte leakage) as well as pericarp browning (browning index and polyphenol oxidase activity), compared with control fruits. In contrast, exposure to cPTIO attenuated ROS content, oxidative membrane damage and pericarp browning of longan pericarp during storage. The severity of pericarp browning, ROS production and oxidative damage depend on SNP or cPTIO concentrations. These findings suggest that NO might be involved in oxidative stress which can contribute to pericarp browning in harvested longan by alteration of the balance between ROS generation and scavenging.

Keywords: Longan, SNP, cPTIO, oxidative damage, ROS, nitric oxide
Effects of exogenous adenosine triphosphate and 2,4-dinitrophenol on membrane stability and chilling injury of harvested ‘Kim Ju´ guava fruit

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Abstract
Depletion of cellular energy and loss of membrane stability contribute to chilling injury (CI) in harvested horticultural crops. In this study, the effects of exogenous ATP and 2,4-dinitrophenol (DNP; ATP production inhibitor) on membrane stability and chilling injury development of guava fruit were investigated. Mature ‘Kim Ju’ guava fruits were dipped in distilled water (control) or 0.5, 1 and 2 mM of ATP or 0.5, 1 and 2 mM of DNP for 30 min, stored at 8 °C for 14 d. It was shown that cellular energy (ATP content and energy charge (EC)) decreased during cold storage. This reduction coincided with the increases in membrane damage (percentage of electrolyte leakage (EL) and malondialdehyde (MDA) content) and CI index as well as a decrease in membrane transport enzyme (H+-ATPase and Ca2+-ATPase) activities. The fruit treated with 1 mM ATP had markedly higher levels of cellular energy and ATPase activity than the control first 14 days. Moreover, the membrane damage and CI index were significantly lower than the control after 10 days. In contrast, treatment with 1 mM DNP exhibited opposite results by reducing cellular energy and ATPase activity and increasing membrane damage and CI index comparing with ATP treatment. These results suggest that chilling injury development of guava fruit associated with a decrease in energy level and loss of membrane stability. Exogenously applied ATP could inhibit chilling injury by improving cellular energy and membrane stability whereas insufficient energy by applied DNP accelerates chilling injury due to the loss of membrane stability.

Keywords: Psidium guajava, chilling injury, energy status, membrane integrity
The effects of sodium azide and 2,4 dinitrophenol on caspases-like activation and peel spotting reduction of harvested `Sucrier´ banana fruit

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Abstract
Prevention of cellular ATP production has been shown to inhibit caspase activation and apoptosis. Here, we investigated the effect of nonlethal dose ATP synthesis inhibitors, sodium azide (NaN3) and 2,4 dinitrophenol (DNP) on caspases-like activation related to cell death and peel spotting disorder of harvested ‘Sucrier’ banana. Treatments with NaN3 (50, 100 and 1000 µM) and DNP (50 and 100 µM) were shown to suppress cellular ATP levels and caspase-like protease (caspase-9 and caspase-3-like protease) activities accompanied by a decrease in peel spotting in dose dependent manner. Treatments with DNP (at the concentration of 100 µM) and NaN3 (at the concentration of 1000 µM) were effective in to reducing ATP levels, caspase-like activities and peel spotting. The decrease in ATP levels improved the cell viability by retarding program cell death activation, indicated by the lower caspase-9 and caspase-3-like activities. These results suggest that NaN3 and DNP could inhibit the caspase-like protease activation and delay the development of peel spotting. Therefore, caspase activation and cell death were dependent on ATP and associated with peel spotting development of ‘Sucrier’ banana.

Keywords: Sodium azide, 2,4dinitrophenol, peel spotting, caspase 3-like, caspase 9-like, ‘Sucrier´ banana
Effect of Postharvest Curing Duration on Black Garlic Physiochemical Properties

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Abstract
This research assessed the influence of initial moisture content on physiological and chemical properties of black garlic. Freshly harvested garlic bulbs were shade-dried at 32-37°C until constant weight reached. The samples were withdrawn every 10 days for the analysis of moisture content and, thereafter subjected for black garlic processing. The physiological and chemical properties of black garlic samples were then identified. Results illustrated that fresh garlic with higher moisture contents gave the products of brown colour, mushy texture and higher pH value. On the other hand, darker colour and elastic texture with lower pH values of black garlic were obtained from the longer cured garlic. The antioxidant activity was higher when the lower moisture content of raw material was used. The chemical compound identification demonstrated that allicin decreased while S-allyl-L-cysteine increased after heat processing. In summary, commercially preferred characteristics of black garlic can be achieved by using the raw material of lower moisture content.

Keywords: Antioxidant, initial moisture content, millard reaction
Role of environmental factors and production site, post-harvest treatments and cold storage temperature on rind biochemical concentrations associated with `Benny´ valencia citrus fruit non-chilling rind pitting

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Abstract
This study aimed at investigating the role of environmental factors, production site and postharvest treatments and cold storage temperature on rind biochemical concentrations in relation to non-chilling rind pitting of ‘Benny’ Valencia citrus fruit. During 2016 and 2017 seasons, ‘Benny’ Valencia citrus fruit were harvested, sorted and graded, thereafter subjected to the following treatments: T\textsubscript{1} = no wax plus dehydration, T\textsubscript{2} = wax plus dehydration and T\textsubscript{3} = wax plus no dehydration. Dehydrated treatments were applied for 3 days at relative humidity of ±45%, thereafter, fruit were stored at -0.6 and 4.5°C for 28 days plus 7 days shelf-life. After withdrawal from cold storage plus 7 days shelf-life, fruit were analyzed for rind pitting incidence (RPI). After RPI analysis, the flavedo was removed, freeze dried, thereafter analysed spectrophotometrically for total phenolic concentrations (TPC), total flavonoid concentrations (TFC), ascorbic acid (AA) and radical scavenging activity (RSA) using. The results showed low environmental relative humidity and vapour pressure deficit increased RPI. Furthermore, RPI was high on fruit subjected to wax plus no dehydration across all storage temperatures and production sites. However, fruit sourced from Tzaneen had significantly (p < 0.001) high TPC and TFC irrespective of postharvest treatments therefore, low RPI. While rind ascorbic acid was higher in fruit from Groblersdal when compared with Tzaneen and Musina, however, low RPI was also observed in fruit sourced from Groblersdal. Moreover, fruit from Musina subjected to wax plus dehydration had higher RSA and low RPI at both temperatures when compared with fruit sourced from Groblersdal and Tzaneen. Therefore, wax plus dehydration resulted in low rind pitting with an increased accumulation of rind biochemical concentrations, irrespective of cold storage temperature. These results suggested that there is a link between rind pitting and rind biochemical concentrations in ‘Benny’ Valencia citrus fruit.

Keywords: Antioxidants, ascorbic acid, citrus fruit, flavonoids, phenolics, rind pitting
Using a modified bicycle pump to store seeds under vacuum

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Abstract
To successfully store orthodox crop seeds in tropical climates one must contend with elevated temperature, high relative humidity, and ongoing pest pressures. The subsequent storage measures necessary for success often come at a high cost to producers, including a combination of modified storage infrastructure, seed treatment, and various container alternatives. This experiment aimed to test the effectiveness of a simple modified bicycle pump designed to pull a vacuum on glass jars, for the storage of orthodox crop seed. In 2018, lablab (Lablab purpureus (L.)) seeds were stored in containers with and without vacuum sealing at two sites, in Myanmar and Thailand. Containers were removed from the experiment at months 0, 3, 6, 9, and 12, and seed were tested to determine germination percentage and seed moisture content. Results indicated a significant advantage in seeds stored under vacuum sealing compared to those stored in ambient environments, with the former maintaining germination percentages above 90% throughout the study, while the latter deteriorated to less than 50% by month 6 of the study. Glass jar containers maintained a vacuum 90% of the time when using the modified bicycle pump technique. Overall, results indicate that seed stored using this appropriate technology can be both effective and affordable, providing potential benefit to smallholder farmers and others in resource-constrained settings.

Keywords: Modified bicycle vacuum pump, seed storage, vacuum sealing, orthodox seed, appropriate technology
Effect of blue LED light irradiation on chlorophyll metabolism in the flavedo of Valencia orange in vitro

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Abstract
Regreening is a phenomenon that mature citrus fruit regain green color accompany with the accumulation of chlorophylls when left unharvested on tree till summer. In the present study, to investigate the effect of blue LED light irradiation on chlorophyll metabolism in citrus fruit during regreening, we cultured the flavedo of Valencia orange (Citrus sinensis Osbeck) in vitro under 50 µmol.m⁻².s⁻¹ blue LED light (470nm) for four weeks at 25°C. The color of the flavedo in the blue LED light treatment turned from orange to green gradually, while the flavedo in the control remained in orange color during the experimental period. Compared with the control, chlorophyll a, chlorophyll b, and total chlorophyll contents were increased by the blue LED light treatment at the fourth week. In addition, microarray assay results showed that the expression of chlorophyll biosynthetic genes (CitHEMA1, CitHEMC, CitHEME2, CitCHLI2, CitGUN4, CitCHLM, CitCHL27, CitPORA, CitCHLG, CitCAO and CitGGDR) was up-regulated by the blue LED light treatment. Under the blue LED light, the high expression of chlorophyll biosynthetic genes led to chlorophyll accumulation in the flavedos in vitro. These results indicated that blue LED light was an important factor for regulating chlorophyll accumulation and inducing regreening in the flavedo of Valencia orange.

Keywords: Regreening, blue LED light, chlorophyll, citrus, microarray
Effect of Blue LED Light Irradiation on Flavonoid Accumulation in the Flavedo of Valencia Orange in vitro

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Abstract
Flavonoids are a group of pigments widely distributed in nature. To date, more than 7,000 kinds of flavonoids have been identified in plants. Citrus fruit is one of the richest sources of flavonoids. In the flavedos of citrus fruit, high amounts of flavonoids, especially flavanones, are accumulated. In the present study, to investigate the effects of blue light on flavonoid accumulation in citrus fruit, we cultured the flavedos of Valencia Orange (Citrus sinensis Osbeck) in vitro under 50 µmol.m⁻².s⁻¹ blue light (470nm) for 1 week at 25 ℃. The changes in the flavonoids contents and expression of major flavonoid biosynthetic genes under the blue light were investigated in the flavedos in vitro. The results showed that contents of the four major flavanones, narirutin, naringin, hesperidin, and poncirin, were increased by the blue light treatment in the flavedos in vitro, and as a result the total flavonoid content in the blue light treatment was higher than that of the control. Gene expression results showed that the flavonoid biosynthetic genes, CitCHS1, CitCHS2, and CitCHI, were significantly up-regulated by the blue light treatment. Under the blue light, the higher expression levels of flavonoid biosynthetic genes led to enhancement of the flavanones contents in the flavedos. These results suggested that blue LED light irradiation was an important factor for inducing flavonoid accumulation in the flavedos of citrus fruit.

Keywords: Citrus, flavonoid, blue LED light
Combined Effects of Hot Water and Eucalyptus Leaf Extract on the Storability of Cyprus Local Mandarin

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Abstract
Current work was conducted to evaluate the influences of hot water dipping (HWD) treatment and its combination with Eucalyptus leaves on the postharvest storability of Cyprus local mandarins. This experiment consisted of five different treatments, which are: 1) control (dipping fruits into tap water for 3 min); 2) hot water dipping (HWD) at 55 °C for 2 min; 3) hot water dipping (HWD) at 55 °C for 3 min; 4) hot water dipping (HWD) + Eucalyptus leaf (EL) at 55 °C for 2 min; and 5) hot water dipping (HWD) + Eucalyptus leaf (EL) at 55 °C for 3 min. Overall results suggested that the incorporating Eucalyptus leaves into the HWD treatment improves the efficacy of the HWD, and makes it possible to reduce the dipping duration required for higher positive impact on the postharvest fruit quality (including weight loss, fruit firmness, visual quality, decay incidence, juice percentage, soluble solids concentration, titratable acidity and ascorbic acid content). According to the main findings obtained, at the end of the experimental study period (60 days of storage), the minimum weight loss, the best visual appearance, minimum decay incidence and highest ascorbic acid content were all observed from the fruits treated with the combination of Eucalyptus leaves and HWD for 2 min duration.

Keywords: Postharvest diseases, weigh loss, fruit visual quality, juice content, soluble solids concentration
Suppression of lignification in postharvest asparagus by hot water treatment

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Abstract

The less fibrous is an important quality of asparagus during storage. This research aimed to reduce the lignification in asparagus by using hot water treatment (HWT) at 45°C for 5 minutes before storage at 4°C and then kept at 24 days. The asparagus dipped in tap water for 5 min was set as a control. The Physical and biochemical changes of asparagus were investigated during storage. The reduction of lignin content was pronounced by HWT. This also delayed the increase of shear force and suppressed the activities of phenylalanine ammonia-lyase (PAL), cinnamyl-alcohol dehydrogenase (CAD) and peroxidase (POD). In addition, HWT resulted in greater decreased of fresh weight loss, color change and hydrogen peroxide (\(H_2O_2\)) content of asparagus during storage compared with the control. Interestingly, total phenolic content in asparagus with HWT was higher than that of the control. From the results, HWT is a safe and effective method to delay the lignin formation in asparagus by suppressing the lignification associated enzymes activity.

Keywords: Lignification enzymes activity, fibrous, lignin, storage
Comparison of hot water and UV-C treatments in controlling postharvest disease and maintaining postharvest quality of 'Nam Dok Mai Si Thong' mango

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Abstract
Mango cv. Nam Dok Mai Si Thong is an economic mango cultivar of Thailand for domestic and international markets. The loss during export is mainly due to disease and quality deterioration. Hot water and UV-C treatments have been reported in their efficacy on control of postharvest diseases and maintaining quality of several fruits. The objective of this study was, therefore, to investigate the potential of hot water and UV-C treatment to control disease and maintain quality of 'Nam Dok Mai Si Thong' mango. The treatments included untreated control, hot water treatment (60°C for 3 min), UV-C irradiation (0.94 kJ m⁻²) and the combination of hot water and UV-C treatments. All treated fruit were stored at 13°C for quality assessment and at 25°C for disease assessment. After 9 days of storage, mangoes dipped in hot water showed a significantly lower disease severity as indicated by smaller lesion diameter (0.42±0.18 cm) than in other treatments (2.25±0.30, 2.76±1.13 and 4.17±1.46 cm for the combined treatments, control and UV-C treatment, respectively). The UV-C irradiated fruit were firmer, lower in total soluble solids and higher in titratable acidity compared to fruit in control, hot water alone and the combination treatments of hot water and UV-C. In addition, UV-C treatment increased total phenolic contents and DPPH activity in peel, where there was no difference in these values in pulp among the treatments. This study suggests that hot water (60°C for 3 min) was the potential means for control of anthracnose disease where UV-C treatment (0.94 kJ m⁻²) exhibited a promising effect on enhancing antioxidant activity in mango cv. Nam Dok Mai Si Thong.

Keywords: Hot water, UV-C, 'Nam Dok Mai Si Thong' mango, anthracnose, postharvest quality, antioxidant activity
Quality characteristics of 'Carabao' mango as affected by preharvest bagging at two fruit maturity stages followed by hot water treatment

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Abstract
The quality of mango fruit is affected by both preharvest and postharvest handling management. The effects of two preharvest bagging materials, namely newspaper and white reusable Taiwan paper bags, used at two fruit maturity stages, (58 and 76 days after flower induction, DAFI) on the harvest quality; and hot water treatment (52-55 °C for 5 min) on the postharvest characteristics of ‘Carabao’ mango were evaluated. Retention of bagged mango fruit at harvest was affected by both bagging materials and maturity stages. Bagging fruit with the Taiwan bag at 76 DAFI resulted in higher retention of fruit at 95.33%. The Taiwan bag while showing a higher percentage of fruit with scab, the degree of defects was low affecting mostly 1-5% of the fruit area. The Taiwan bag also resulted in a higher percentage of fruit with export quality grade. Bagging of fruit at the later stage of 76 DAFI reduced the degree and percentage of fruit with anthracnose while increasing the total soluble (TSS) solids of fruit. Newspaper bag advanced the ripening of fruit as indicated by rapid peel color change, increased weight loss and TSS. Taiwan bag and hot water treatment provided some control of the development of anthracnose and stem end rot resulting in better quality and longer shelf life. Preharvest bagging with Taiwan bag at 76 DAFI and hot water treatment showed efficacy in controlling the diseases, maintained better quality and prolonged the shelf life of ‘Carabao’ mango.

Keywords: Anthracnose, hot water treatment, preharvest bagging, shelf life, stem end rot
Improving postharvest quality of tomato with the application of electric field treatment

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Abstract
High electric field exposure has been shown to reduce respiration in various fruits and vegetables while also extending the freshness. The polygalacturonase (PG) in tomato is a developmentally regulated cell wall hydrolase involved in changes of cell wall pectin during ripening. This study was conducted to determine the effect of electric field (EF) treatment on improving postharvest quality and storage life of tomatoes, as well as to measure the polygalacturonase (PG) enzyme expression. Tomatoes (Lycopersicon esculentum) at developmental stage 4 were purchased from a farm and brought to the laboratory to be sorted from defects and disease, as well as uniformity of size and shape. The fruit were continuously treated with alternating current (AC) and direct current (DC) of field strength at 200 kV/m until 3 weeks of storage at 10 °C. While the fruit kept in an EF environment with target AC and DC at 0 V was served as a control. Tomato fruits were sampled during storage on day 7, 14 and 21 for evaluating of skin colour, firmness, weight loss, titratable acidity, pH, total soluble solids (TSS), sugar-acid ratio, ascorbic acid, and polygalacturonase (PG) activity. The experimental design was a completely randomized design (CRD) with three replications. The obtained data were analyzed using analysis of variance (ANOVA) and mean comparison was tested by the Duncan Multiple Range at the 5% level of significance. The result showed that DC-EF treatment improved the firmness and L value of tomato fruits throughout 3 weeks of storage. For the conclusion, DC-EF had the potential to be used to extend the shelf-life and to suppress the PG expression level of tomato fruits.

Keywords: Electric field, prolong shelf life, improve quality, firmness
Synergistic effect of pre-harvest treatments on storability of date palm fruit (*Phoenix dactylifera* L. cv. Khenizi)

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**Abstract**

Dates are the most popular fruits consumed in the Gulf countries, and ‘Khenizi’ cultivar is one of the main recognized date palm varieties in UAE. It is commonly consumed fresh at the Bisr or Rutab stage of ripening. However, this stage has a limited shelf/storage life even with refrigeration; the fruit becomes very soft and loses its marketability. Therefore, this study aimed to investigate the synergistic impact of preharvest spray treatment with the natural elicitor chitosan (Ch) alone and in combination with calcium chloride (Ca) and salicylic acid (SA) on the fruit quality and storage life of ‘Khenizi’ date during cold storage at 2°C and 90-92% relative humidity (RH). Several quality parameters of the fruit, including physicochemical characteristics and phytochemical content were determined at harvest and during cold storage for 10 weeks. The results indicated that Ch+Ca and Ch+SA treatments significantly improved fruit shelf life and delayed ripening/senescentce of fruits during the storage. These treatments had lower percentage of decay and lower weight loss compared to the control and other treatments. This fruit also had the best color quality, phenolic content, and antioxidant activity. No different among treatments for the total soluble solids (TSS) that was significantly lower compared to the control fruit. Based on these findings, we concluded that the delay in senescence and reduction in fruit decay might be due to the synergistic effect of these elicitors on the ripening process. The results of this study suggest that preharvest treatment with a combination of chitosan, and salicylic acid or calcium chloride may have potential for extending storage life of ‘Khenizi’ date fruit by preserving quality and minimizing postharvest microbial deterioration.

**Keywords:** Cold storage- decay, senescence, date, antioxidant
A coating formula developed from *Neolitsea cassia* leaf extract extends storage life of lime (*Citrus aurantifolia*) fruit

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**Abstract**

Lime fruit, a non-climacteric, seasonal crop become unmarketable after 6-7 days from harvesting. Hence, a study was conducted to develop *Neolitsea cassia* leaf mucilage-based wax coating with the objective of maintaining the internal and external quality of lime (*Citrus aurantifolia*) fruit for extended postharvest life. Leaf extract of 75% *N. cassia*, 3% sunflower oil, 2% lecithin and 20% glycerol were included in the developed formula. Lime fruit harvested at the commercial maturity were brought to the laboratory and divided into four lots each containing 100 fruit. Two lots of lime fruit were dipped in the developed coating for one minute. Then both coated and non-coated fruit were kept in plastic crate and stored in ambient (32°C ± 2°C, RH 70%) and cold room conditions (10°C ± 2°C °C, RH 85%). Evaluation of physicochemical attributes were conducted before treatment and thereafter at 2 days interval for limes stored at ambient condition and 8 days interval for limes stored at cold room until the fruit exhibit limit of marketability. Limes that were coated showed highest storage life of 12 days under ambient conditions and minimum of 48 days when stored under cold room conditions. The fruit also displayed green color of peel at the end of 48 days. Lowest storage life was shown by non-coated fruit kept under ambient condition of which marketable life was ended by 6 days. The lowest rate of peel yellowing (P< 0.05), higher firmness, lowest physiological weight loss, higher acidity, higher ascorbic acid content and higher soluble solids was maintained by coated lime stored in low temperature conditions.

**Keywords**: Edible coating, plant mucilage, physiochemical attributes, marketable life, low temperature conditions, non-climacteric
Comparison of storage method and packaging material on physicochemical of fresh-cut melons (Cucumis Melo L.) during distribution

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Abstract
The purpose of this study was to determine the effect of storage methods and packaging materials for fresh-cut melon on changes in physicochemical properties during the distribution process. Variation of packaging materials used were polypropylene, plastic wrap, and without packaging as control. The ice gel in cooled box delivery was used for storage method during distribution and compared to conventional methods (manual fruit carts). The physical parameters of melons fruit observed during distribution were weight shrinkage, hardness level, pH value, and total dissolved solids (TDS). The fresh-cut melons were stored in a distribution box which kept the temperature in ±18°C for 6 hours. The results showed that the storage method had a significant effect (p < 0.05) on all parameters of physical quality. While packaging material had a real effect (p < 0.05) on shrinking weight and TDS but has no real effect (p < 0.05) on hardness level and pH value. Packaging using plastic wrap can reduce the shrinking weight of fresh-cut melons, while PP plastic can maintain the hardness level, pH value, and TPT of cut melons fruit.

Keywords: Box delivery, ice gel, plastic wrap, polypropylene, temperature
Effects of Coating and Temperature during Storage on Antioxidants of mango fruit cv. Nam Dok Mai Sithong

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Abstract
Mango (Mangifera indica L.) cv. Nam Dok Mai Sithong is an economically important fruit in Thailand. The problem of mango during storage and export is the quality of the products decrease and lead to unacceptable by consumers. Coating treatment has been used to prolong shelf life of fresh fruit however the optimal storage temperatures must be concerned. The aim of this study was to investigate the effects of carnauba wax and storage temperatures on phenolic, flavonoid and β-Carotene contents in mango cv. Nam Dok Mai Sithong. Experiment was conducted based on 6 × 2 factorial in a completely randomized design. Fruits were coated with chitosan at 1.5 and 2% and carnauba wax at 20 and 25%, and then stored at 10 and 25°C. Samples were randomly collected every 3 days interval. The results showed that phenolic, lycopene and β-carotene contents tended to decrease with progress of storage time. The storage life for 9 days was the best in term of consumer acceptance, and high contents of lycopene and beta-carotene in Nam Dok Mai Sithong mango. The best result from this research was mango fruit coated with carnauba wax at 20% and stored at 10°C which maintained high contents of lycopene and beta-carotene.

Keywords: Phenolic, lycopene, β-Carotene, chitosan, carnauba
High Oxygen Pretreatment Affects Stored Quality and Antioxidant Capacity of Strawberry (Fragaria x ananassa Duch.) during Cold Storage

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Abstract
The effect of short-time 8-hours pre-treatment at 5°C using pure oxygen on the skin color of fruit and its calyx, ascorbic acid content, total anthocyanins, antioxidant capacity, respiration, and decay index of strawberries was investigated. Freshly harvested strawberries cv. ‘Parajatan #80’ at 75% red skin color were pretreated with 100 % oxygen or with air (control) then packed in perforated clamshells and stored at 10°C, 95±2 % RH for 10 days. The short-time high oxygen had advantageous effect on developing peel color and delaying chlorophyll loss in the calyx of fruits, maintaining a higher concentration of ascorbic acid, total anthocyanins, and antioxidant capacity based on free radical scavenging activity (DPPH) and ferric reducing antioxidant power (FRAP) than that of control. Strawberries pretreated with pure oxygen for 8 hours had a lower level of decay index of 1 (1-5% decay) than the control and had storage life for 8 days. In conclusion, short-time high oxygen pretreatment could be a potential method for preserving external fruit quality, internal quality such as antioxidant compound and antioxidant capacity and slow down the occurrence of fruit decay.

Keywords: Anthocyanins, antioxidant, decay, oxygen-enriched, postharvest quality
Effect of gaseous ozone treatment on mancozeb fungicide residue degradation and quality of ‘Jinda’ chili (*Capsicum annuum* L.) fruit during storage

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**Abstract**
The mancozeb fungicide is commonly used to combat fungal diseases in a variety of fruits and vegetables. Unfortunately, its residues remain present in fresh produce represent a threat to food safety and human health. Reducing toxic residues are urgently required. Using ozone fumigation treatment at concentration of 0, 15, 25 and 50 ppm for 30 or 60 min then stored at 25 °C along with 12 days, the reduction of mancozeb fungicide residues and fruit quality of ‘Jinda’ chili was determined. From this study ozone fumigation between 25 to 50 ppm for 30 or 60 min showed the effective treatment to remove the mancozeb residues by 47 to 62% according to GT-test Kit method and analysis colorimetric by spectrophotometer at absorbance 540 nm. The most effective treatment was found at concentration of 50 ppm for 30 min. Moreover, all ozonation treatment also delay postharvest loss and maintained the quality of chili by higher the fruit firmness and lower color development by which the important parameter of chili marketing, indicated by delay the increasing in a*, b* and decreasing in hue angle values. The fruit color coincided with higher chlorophyll (Chl) content (Chl a and b) than that of control. The maintaining fruit quality after ozone exposure accompanied by the decrease in ethylene production and respiration rate. These results suggest that ozone fumigation treatment at 50 ppm could be a useful and effective method to reduced mancozeb fungicide residues and maintain postharvest quality of ‘Jinda’ chili during storage at 25 °C for 12 days.

**Keywords:** Ozonation, ‘Jinda’ chilli, ethylene, chlorophyll content, mancozeb
Usages of Thai basil oil vapour in controlling Colletotrichum sp. in post-harvest storage of mangoes var. Nam Dok-Mai

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Abstract
In the development of natural antifungal agent during postharvest storage of Nam Dok-Mai mangoes, this study aims to investigate the inhibition of Colletotrichum sp., the major pathogen caused mangoes postharvest disease, by Thai basil (Ocimum basilicum var. thyrsiflora) oil vapour. The in vitro fungus inhibition was conducted on the duo culture plate using the oil raged from 50 – 1,500 µL L⁻¹ air space. The ex-vitro study was by storing commercially mature mango (ca. 450 g) fruit in a 1-litre perforated plastic container (with 12 needle holes) with 0, 13, 25, 63, 250 and 500 µL of the essential oil on the cotton balls. The appearance and physical characteristics of the mangoes was observed. The results showed that Thai basil oil illustrated > 50% inhibition with 125 µL L⁻¹ air space. The ex-vitro study result showed that the lower amount of oil (25-13 µL) could maintain acceptable characteristics of mangoes. Consequently, Thai basil oil has the potential as a natural antifungal agent for maintain appearance quality of postharvest mangoes.

Keywords: Appearance, mangoes postharvest disease, Ocimum basilicum var. thyrsiflora, storage mangoes
Impact of bio-control management on post-harvest characterization of Chinese flowering cabbage

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Abstract
Insecticide is the most practical method that has been widely used for a decade to produce sufficient world food supply. The rotation of insecticide groups can avoid resistance but the misused can lead to tremendous toxic residue on products. Therefore, the objective of this study was to assess the impact of bio-control agents on post-harvest parameters in Chinese flowering cabbage. Result revealed that weight loss from bio-control plot had significantly difference in day 3 to day 6 at 22.54±9.21 and 29.52±9.24% compared to insecticide used plot at 61.97±9.41 and 61.84±9.47%, respectively. The value of stem width from bio-control plot at day 0, 3 and 6 were 3.48±0.46, 2.98±0.33 and 2.95±0.45 cm. which were greater than insecticide used plot at 2.72±0.41, 2.13±0.46 and 1.82±0.33 cm., respectively. The firmness value correlated fairly well with storage period. The firmness values of bio-control plot (36.13±6.74 N) was lower than insecticide used plot (54.37±7.33 N) at day 6. There was no significantly difference found between the treatments in leaf coloring (L*, a*, b* value) but chlorophyll a and b contents at day 5 were differed statistically significant (P < 0.05).

Keywords: Chinese flowering cabbage, bio control, weight loss, stem width, firmness, color index, chlorophyll content
Efficacy of citral vapour in controlling postharvest green mould decay of citrus fruit

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Abstract
Citral, a monoterpenic aldehyde, was examined both in vitro and in vivo on Navel orange for its effect on Penicillium digitatum, the fungi responsible for green mould of citrus fruit. The monoterpenes limonene and linalool were also evaluated for comparison. In vitro testing showed citral vapour at 1 to 5 µL disc⁻¹ significantly inhibited fungal growth compared to control, limonene and linalool. Inoculated oranges were fumigated with citral, limonene and linalool at 20°C inside sealed containers with 1 mL of each compound on a glass petri dish in a bag with 20 fruits for 6, 12 and 24 hr, followed by storage at 20°C. Citral and linalool vapour significantly inhibited fungal wastage compared to control with magnitude of effectiveness being exposure for 24 hr > 12 hr > 6 hr with citral having greater reduction of fungal wastage than linalool. Fumigation with limonene showed no antifungal activity. Fumigation of oranges with citral did not show rind injury, hence fumigation is a potential technology to control development of green mould (P. digitatum) in citrus fruit.

Keywords: Citral, Penicillium digitatum, monoterpenic, fumigation, green mould
Effect of a novel ABA receptor antagonist 3’-hexylsulfanyl-ABA (AS6) on ascorbate metabolism in postharvest broccoli

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Abstract
Broccoli is a perishable vegetable, which senesces rapidly after harvest. During senescence, the florets of broccoli turn yellowing, and the contents of the bioactive compounds decrease to low levels. The occurrence of senescence significantly reduces the nutritional and commercial values of broccoli. In this study, to delay the senescence of broccoli, we treated the broccoli with a novel ABA receptor antagonist 3’-hexylsulfanyl-ABA (AS6) after harvest at room temperature, and its effects on broccoli senescence were investigated. The results showed that the yellowing process was delayed by the treatment of AS6. On the fourth day after harvest, the florets displayed obvious yellowing in the control, while most of the florets still remained green in the treatment of AS6. With the treatment of AS6, ethylene production was reduced during the storage period, and the peak of ethylene production in AS6 treatment was significantly suppressed as compared with the control on the third day after harvest. In addition, we found that the AS6 treatment up-regulated the expression of BO-VTC1, BO-MDAR1, BO-MDAR2, and BO-DHAR, while down-regulated the expression of BO-APX1, BO-APX2, and BO-sAPX. The higher expression levels of the AsA biosynthetic and regeneration genes, and the lower expression levels of the AsA oxidation genes led to the reduction of AsA loss in the AS6 treated florets after harvest. The results presented in this study suggested that postharvest applications of AS6 was effective to delay the senescence of broccoli during the storage. These results will provide new insights into maintaining the high quality of broccoli after harvest.

Keywords: ABA receptor antagonist, AsA, broccoli, florets, postharvest senescence, yellowing
Characterization of Pigments Accumulation in Valencia Orange During Regreening

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Abstract
The regreening of Valencia orange was a phenomenon that the flavedo of fruit regains green color when left the fruit on the tree till the summer season. This process was related to pigment including carotenoid and chlorophyll accumulation in the flavedos. It was reported that the reversion of chromoplast to chloroplast occurred during the regreening. In this study, the changes of carotenoids and chlorophylls contents in the top and the bottom parts of fruit were investigated in the Valencia orange during the regreening. The research was started from April to June. The regreening of citrus fruit was observed and the color of fruit changed from orange to green when left on tree until June. The color change of flavedo was described by the hue angle and citrus color index (CCI) in the top and bottom part of fruit. During regreening, the hue angle increased and the CCI decreased in both parts of the fruit. The top part of the fruit showed higher hue angle and lower CCI than the bottom part. The increasing of green color in flavedo was related to chlorophyll accumulation. The content of chlorophyll including chlorophyll a, chlorophyll b, and total chlorophyll increased gradually in the flavedo. The top part of fruit accumulated more chlorophyll than the bottom part. In contrast, the contents of total carotenoid and the five major carotenoids (all-trans-violaxanthin, 9-cis-violaxanthin, lutein, β-cryptoxanthin, and β-carotene) decreased rapidly in flavedo throughout the experiment period. The contents of total carotenoid, 9-cis-violaxanthin and β-cryptoxanthin in the bottom part were higher than the top part, while the contents of lutein and β-carotene in the top part were higher than the bottom part of the fruit. The results conclude that the contents of chlorophylls increased gradually, while the contents of carotenoids decreased rapidly in the flavedo during regreening. In addition, the regreening was more obvious in the top part of the fruit than the bottom part, which indicated that the regreening process might start from the top part of the citrus fruit.

Keywords: Carotenoid, chlorophyll, regreening, valencia orange
Comparison of substrate reactivity of polyphenol oxidase and browning symptom of fresh cut mango `Nam Dok Mai Si-Thong´ and 'Nam Dok Mai No. 4' in vitro and in vivo

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Abstract
'Nam Dok Mai no. 4' and 'Nam Dok Mai Si Thong' are popular cultivars for fresh cut mango product in Thailand. Fresh-cut mango is considered as one of the most consumed products with the increasing market growth year by year. However, there are problems of fresh-cut mango due to surface browning and microbial contamination. This research was studied on the comparison of substrate reactivity of polyphenol oxidase and browning symptom of fresh-cut mango cv. Nam Dok Mai Si Thong and Nam Dok Mai No. 4. Enzymatic browning of both Nam Dok Mai mango revealed that Polyphenol oxidase activity (PPO) in 'Nam Dok Mai Si Thong' was higher than 'Nam Dok Mai No. 4' mango. Five phenolic substrates of PPO including caffeic acid, catechol, chlorogenic acid, 4-methyl catechol and pyrogallol was individually dropped onto 'Nam Dok Mai Si Thong' and 'Nam Dok Mai No. 4' mango pulp surface for testing the specific substrates of 'Nam Dok Mai' mango's PPO (in vivo). 'Nam Dok Mai No. 4' mango cubes underwent darker browning symptom when treated with chlorogenic acid, 4-methyl catechol and caffeic acid, respectively, while 'Nam Dok Mai Si Thong' mango cubes showed a darker color when treated with 4-methyl catechol, catechol and pyrogallol. In vitro, The specificity of PPO activity of mango extract was determined using various substrates as caffeic acid, catechol, chlorogenic acid, 4-methylcatechol and pyrogallol. PPO extracted from 'Nam Dok Mai Si-Thong' and 'Nam Dok Mai No.4' mango was more actively specific to catechol and 4-methylcatechol than other substrates which revealed the higher activity of PPO.

Keywords: Fresh cut mango, enzymatic browning
Expression of differentially expressed genes associated with `Benny´ valencia citrus fruit non-chilling rind pitting disorder

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Abstract
Investigating the genes differentially expressed in citrus rind during pitting would be an effective tool to protect citrus fruit quality. Therefore, this study was conducted to investigate genes associated with rind pitting of ‘Benny’ Valencia citrus fruit. During 2017 seasons, fruit were harvested from Tzaneen, Groblersdal and Musina in South Africa. Afterwards, fruit were subjected to the following treatments: T1 = no wax and dehydration, T2 = wax and dehydration and T3 = wax and no dehydration. Treatments were applied for 3 days at relative humidity of ±45%, thereafter; fruit were stored at -0.6 and 4.5 °C for 28 days plus 7 days of shelf-life. After peel pitting analysis, the flavedo was removed, store at -80°C and used to analyse differentially expressed genes in citrus rind by quantitative RT-PCR method. The pitting rind and no-pitting rind were selected as the tester and driver, respectively. Three homologic genes: CsCP gene; CsNAC-domain protein gene; CsCP-F gene; were chosen to examine the relationship between their expression and citrus rind pitting through quantitative RT-PCR analysis in pitting and no-pitting fruits. Results showed that the expression of CsCP, CsNAC and CsCP-F genes were all higher in fruit harvested from Tzaneen and low peel pitting was observed. Groblersdal and Musina fruit had low genes expression and low rind pitting was also observed. Therefore, findings suggested that CsCP, CsNAC and CsCP-F genes may be linked with rind pitting and could serve as targets for future investigation.

Keywords: Cold storage temperature, CsCP gene, CsCP-F gene, CsNAC gene, rind pitting
Curcuminoids extraction from turmeric (Curcuma longa) using ultrasound-assisted extraction as anti-browning agents

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Abstract
The purpose of this research was to extract curcuminoids from Turmeric (Curcuma longa) which are used to prevent browning in the fresh-cut fruit. Turmeric was extracted using ultrasound-assisted extraction (UAE) with 95% of ethanol. The power was varied at 160, 280 and 400 W for 10 min. Turmeric extracted by UAE with 95% of ethanol at 160W had the highest total curcuminoid, total phenolic and total flavonoid contents of 360.50 mg crude extract content, 312.03 mg GAE/g crude extract and 1,598.89 mg QE/g crude extract. Moreover, this extract had the highest curcuminoid derivatives, such as curcumin I, demethoxycurcumin and bisdemethoxycurcumin at 104.71, 72.82 and 91.36 mg crude extract, respectively. Then, the extract was encapsulated with 30% gum arabic (wall material) by spray drying at 130, 150 and 170°C. The result showed that water evaporated rapidly at 170°C, resulting in a perfectly rounded external surface. The total curcuminoids, phenolics and flavonoids of encapsulated powder were 33.68 mg g⁻¹ crude extract, 37.70 mg GAE g⁻¹ crude extract and 126.76 mg QE g⁻¹ crude extract, respectively. The encapsulated curcuminoids significantly inhibited tyrosinase with an IC50 of 10,698 ppm, which were applied to fresh-cut apple at concentration of 0, 0.05, 0.1, 0.25, 0.5, 1 and 2% (w/v). All samples were packed in closed containers polypropylene (PP) and stored at 4 °C. The sensory evaluation of fresh-cut apple dipped with 0.25% (w/v) encapsulated curcuminoids had acceptability scores for the least curcumin odor, without severity of browning, and moderate sweetness and bitterness. The quality of fresh-cut apple could be maintained for 5 days.

Keywords: Anti-browning, curcuminoids, encapsulation, extraction, turmeric
Effect of calcium ascorbate infiltration against browning in fresh cut apple

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Abstract
This research aimed to study the effect of calcium ascorbate (CaAs) infiltration against browning in fresh cut apple in fresh cut apple. Pieces of fresh cut apple were treated with filtrated water (control), dipped in 20 g L⁻¹ CaAs solution, and infiltrated with 20 g L⁻¹ CaAs for 30 sec. The fresh cut samples were then kept in plastic bag at 4°C for 15 days. The results showed that the infiltration with CaAs was the best treatment to suppress browning on the cut-surface apple significantly in compared with the control. CaAs infiltrated fresh cut apple showed highest lightness (L*) value, lowest color difference (ΔE) and browning index, moreover CaAs infiltration also maintained weight loss. Although firmness, soluble pectin and insoluble pectin contents of CaAs infiltrated fresh cut apple were no significant differences with the control. But it seemed that CaAs infiltration had the potent to maintain firmness and suppressed the decrease of insoluble pectin content. This result indicates that CaAs infiltration at 20 g L⁻¹ can be a promising treatment to suppress browning in fresh cut apple.

Keywords: Anti-browning, infiltration, generally recognized as safe (GRAS), minimally processing
Abstract
The production of potato minitubers serves as an efficient way of increasing seed potato production. However, potato minitubers exhibit a dormancy period that is longer than potato tubers. This study evaluated the effects of various GA$_3$ concentrations on two potato minituber sizes in terms of dormancy breakage and sprouting. Small (3 g to 8 g) and medium (9 g to 15 g) G-0 ‘Granola’ potato minitubers were treated with 1, 5, 10, and 25 mg L$^{-1}$ GA$_3$ with 0 mg L$^{-1}$ GA$_3$ (untreated) and 0 mg L$^{-1}$ GA$_3$ (water-treated) as control treatments. G-0 potato minitubers treated with 25 mg L$^{-1}$ GA$_3$ had the highest sprouting percentage, apical sprout length, and sprouts per minituber at 16 weeks after treatment (WAT). It also exhibited the shortest dormancy period among all GA$_3$ treatments (106.6 days). Relative to small minitubers, medium minitubers showed a higher sprouting percentage (84.83%) with longer and more sprouts per minituber at 16 WAT and a dormancy period of 105.5 days.

Keywords: Dormancy, gibberellic acid, G-0 potato minitubers, minituber size, sprouting, duration
Efficiency of pretreatments of redox agents on delaying the pericarp browning of fresh longan during storage

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Abstract
Rapid pericarp browning is a major postharvest concern for fresh logan logistics. Sulphur dioxide (SO₂) fumigation has widely been used for effectively limiting the problem, but the remaining chemical residue is harmful to human health. The research objective was to use redox agents as alternative pretreatments to delay the pericarp browning of fresh postharvest longan. Pretreatments of fruit dipping in 0.05% peracetic acid in 1.0% oxalic acid (0.05% PAA+1.0% OA) and 1.0% sodium metabisulphite in 1.0% oxalic acid (1.0% SMS+1.0% OA) were compared with SO₂ commercial fumigation and non-treated control. All fruit were then stored at 5°C, 90-95% RH. After treatments, SO₂ and 1.0% SMS+1.0% OA treated fruit showed a bleaching effect on the pericarp colour. SO₂ treatment effectively inhibited the pericarp browning, whereas 1.0% SMS+1.0% OA treatment delayed the browning, but 0.05% PAA+1.0% OA treatment had less effect. There was no visual disease infected on fruit fumigated with SO₂ throughout 15 days of storage, while other treatments initially showed after day 9. Changes in aril soluble solids of fruit during storage were not affected by treatments. SO₂ remaining residue in the pericarp was 1,247 ppm after treatment and remained stable, while it was less than 10 ppm in 1.0% SMS+1.0% OA treatment throughout 15 days of storage. On the other hand, SO₂ remaining residue in the meat was about 100 ppm during the first 6 days of storage, while it was non-detected in the 1.0% SMS+1.0% OA. Consequently, 1.0% SMS+1.0% OA treatment could be an alternative to reduce the longan pericarp browning during storage.

Keywords: Dimocarpus longan, peel browning, sodium metabisulphite, peracetic acid, oxalic acid
Improvement of ground water quality by supplementing Alum on vase life solution in Chrysanthemum cut flower

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Abstract
Dasada Blossom Company is a operate cut flower business at Da Lat, Vietnam. In the highland location had plenty of natural ponds and ground waters which allow the company to apply the groundwater (GW) into their company post-harvest system. This might bring some deteriorating problem in cut flower by vascular blockage. The study aimed to extend vase life of Dendranthema grandiflora var. ‘Celebrate’ by conducted the experiment in Completely Randomize Design (CRD) with the application of aluminum sulfate (Al₂(SO₄)₃) or ‘Alum’ to improve the quality of GW before treated with chemical substance as vase life solution: 1) groundwater (GW), 2) GW + 40 ppm of Alum, 3) GW + 150 ppm of citric acid + 5% of sucrose, and 4) GW + 40 ppm of Alum + 150 ppm of citric acid + 5% of sucrose. The result found that adding Alum into GW as vase life solution had decreased pH but, increased EC. GW without Alum gave the fastest flower blooming score in ‘Celebrate’ plant which led the flower to shorten vase life. While application of 40 ppm Alum + GW gave the plant to create the highest daily water uptake rate and lowest % initial inflorescence FW change. The most delaying flower blooming score exhibited in GW + 40 ppm of Alum + 150 ppm of citric acid + 5% of sucrose. It therefore represented the modify alternative method to improve GW quality before use as vase life solution in Chrysanthemum cut flower.

Keywords: Chrysanthemum, extended vase life, groundwater, aluminum sulphate, purify water
Methyl jasmonate increases the accumulation of anthocyanins in Vanda ‘Sansai Blue’ cut flowers

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Abstract
Cut flowers of Vanda ‘Sansai Blue’ orchids are very attractive due to their light blue big size florets, which possess a beautiful shape pattern. Anthocyanins were found to be the main pigments in Vanda ‘Sansai Blue’ flowers. Since methyl jasmonate (MJ) and sugars were reported to promote anthocyanin content and delay senescence in flowers and fruits, we examined the effects of MJ and sucrose application on accumulation of anthocyanins and appearance of senescence symptoms in petals of cut flowers of Vanda ‘Sansai Blue’ during vase life. Two experiments were conducted in which MJ with or without sucrose were applied in the vase solution, which contained 140 mg L⁻¹ of active chlorine to avoid bacterial contamination, in a controlled observation room (21 ± 2°C, 70-80% RH, cool-white fluorescent light for 12 h/d). The cut flowers were incubated in three concentrations 0.7, 1.1 and 1.6 mM of MJ solution, and control flowers were incubated in distilled water and 140 mg L⁻¹ active chlorine. The best MJ concentration was found to be 1.1 mM, and therefore its effect on the quality parameters was further examined in combination with 2% sucrose. The results showed that treatment with 1.1 mM MJ alone significantly increased the accumulation of total sugar and anthocyanin contents in the petals, and delayed flower senescence, without affecting the flowers fresh weight and their water uptake. Adding 2% sucrose to the 1.1 mM MJ solution resulted in only a slight improvement in the anthocyanin content during the initial 6 days of vase life compared to MJ alone. However, the increase in vase life in response to the combined treatment was significant when compared to MJ alone. In conclusion, the results suggest that a continuous application of MJ may improve the anthocyanin content in petals of cut flowers of Vanda ‘Sansai Blue’ orchids, thereby preserving their quality for about 13 days.

Keywords: Vanda, anthocyanin, sugar, senescence, vase life
Cytokinin, gibberellic acid and sugar improve the quality and extend the longevity of cut Costus flowers (Costus sp.)

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Abstract
Costus flower is often characterized and distinguished from relatives such as Zingiber (true ginger) by its spiraling stems. However, the main senescence symptom of Costus flowers accompanies visible changes which include loss of chlorophyll in the stem within 4 days after harvest and wilting bract. To ensure the best quality of flowers, treatments for extending the vase life of cut costus flowers are needed to maintain after harvest. Gibberellic acid (GA3) is considered to be a senescence-delaying plant growth regulator. Therefore, the objective of this experiment was to determine the effect of cytokinin, gibberellin acid and sugar on improving the quality and extending the longevity of cut Costus flowers (Costus sp.). Costus flowers were held in deionized water (DI) as a control, 50 ppm 6-Benzyl alanine (BA), 1 % sucrose (SU), 0.5 µM Gibberellic acid (GA3), and BA+GA3+SU and placed in an observation room (21±2 OC, 60-70% RH under cool-white fluorescence lights for 12 h/d throughout the experimental period. All treatments were added 50 ppm sodium dichloroisocyanurate (DICA) to prevent the growth of microbial in the solution. It was revealed that the combination of BA+GA3+SU and BA alone gave the best results in delaying the yellowing stem of cut Coctus for 12 and 11.5 d respectively, while the control had more than 50% of yellowing stem within 4.0 d, which was closely related to the content of total chlorophyll. Treatments of BA alone and BA+GA3 and BA+GA3+SU had significantly higher total chlorophyll content in the stem than that of SU and DI although the content of total chlorophyll in all treatments continuously decreased throughout the vase period. Besides, adding cytokinin, gibberellin and sugar in the vase solution induced higher accumulation of anthocyanin in the bract than treatments of DI (control).

Keywords: Costus, cytokinin, gibberellic acid, sucrose, vase life
Effect of oxalic acid on quality parameters of basil leaves

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Abstract
This research evaluated the effect of oxalic acid (OA) on basil leaves to assess the quality parameters such as greenness (-a*), total chlorophyll, wiltness index, chilling injury, weight loss, electrolyte leakage, malondialdehyde (MDA), polyphenol oxidase (PPO) and peroxidase (POD). The herbs were dipped in 1 and 10 mM OA for 5 min and were compared with the untreated herbs (control). The treated basil leaves were air-dried and placed in polyethylene plastic bags and then stored 8+2°C for 8 days. The basil leaves dipped in 1 and 10 mM OA showed a delayed color change (a*) wiltness index, chilling injury, weight loss, electrolyte leakage and malondialdehyde (MDA) accumulation more than the control herb. The basil leaves dipped in 1 and 10 mM OA had decreased total chlorophyll, with a higher total chlorophyll than the control after 8 days in storage. The polyphenol oxidase (PPO) and peroxidase (POD) activity of the basil leaves dipped in 1 and 10 mM OA were lower than those of the control. The herb dipped in 10 mM OA reduced chilling injury more than the basil leaves dipped in 1 mM OA during storage. OA was proved efficient in maintaining the quality of basil leaves during 8 days of low temperature storage.

Keywords: Chilling injury, oxalic acid, methyl jasmonate, sweet basil
Effect of short-term anoxia on chlorophyll and sensory attributes of carambola fruit cv. See-Thong

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Abstract
A fresh fruit is an importance for health because it has an abundant source of phytonutrients. Changes the surrounding atmosphere is a technique for extent shelf-life of fresh produces. The aim of this study was to investigate the effect of short-term anoxia treatment on chlorophyll degradation and organoleptic properties of carambola fruit cv. See-Thong. A different stage of carambola fruit namely ‘green-mature’, ‘color-break’ and ‘ripe’ stage was used in this study. The periods of anoxia treatment were set at 0 (control) and 24 h using humidified nitrogen gaseous with a flow rate at 100 ml.min⁻¹. Sensory quality attributes (using preference test; 5-points hedonic scales and disorder evaluations) were periodically analyzed 2 days interval during storage at 25±2 °C until commercially unmarketable. The results showed that treated with 24 hr anoxia was no significant difference among every stage of overall appearance, freshness and defect score whereas it had trend to higher score of sweetness. However, stage of carambola was significant difference. Overall appearance and freshness of ‘green mature’ stage had highest score and following by ‘color-break’ and ‘ripe’ stage, respectively (P≤0.01) but defect score of ‘color-break’ stage had highest. At 0 and 6 days after storage, sweetness of ‘green-mature’ stage was lowest than ‘color-break’ and ‘ripe’ stage, respectively (P≤0.01). Off-odor and off-flavor were not detected in all treated samples throughout storage period. Moreover, at each stage, anoxia treatment had no significant effect on chlorophyll a degradation. ‘Mature green’ stage had chlorophyll a higher than ‘color-break’ and ‘ripe’ stage, respectively (P≤0.01).

Keywords: Carambola, anoxia, stage, sensory, chlorophyll
Development of Electrospun Nanofibers Containing Methyl Jasmonate for applying in Postharvest fruit and vegetable

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Abstract

Development of a nanofiber sheet containing methyl jasmonate produced by electrospinning technique for delaying senescence in perishable crops was studied. Nanofibers contain highly porous mesh with their large surface-to-volume ratio which is much advantage for improving performance for many applications. This research aims to develop the nanofiber sheet containing methyl jasmonate. First study was to produce the proper nanofiber sheet by varying the combination of three polymers as chitosan, cellulose and gelatin for nanofiber sheet. Nanofiber sheets of various proportions of chitosan, cellulose and gelatin as 40:10:50, 40:20:40, 40:30:30 (Chitosan : Cellulose : Gelatin) was produced by using electrospinning machine. The distance of polymer shooting, flow rate of polymer injection and potential difference of electricity supply was varied to find the suitable condition for producing the carried nanofiber sheet. The result revealed that the 40:30:30 (Chitosan : Cellulose : Gelatin) with 10 cm of polymer shooting distance, 11.67 µL/min of polymer flow rate and 23 KV of potential difference was the best condition for producing the nanofiber sheet. Afterward, this condition was chosen to the further experiment. The various concentrations of methyl jasmonate was added into the polymer solution prior to shooting the nanofiber by electrospinning machine. The results suggested that 5 mM methyl jasmonate electrospun nanofibers revealed the proper morphology with the smallest size of fiber diameter without any droplet of bead, easy to crake. This treatment could potentially be used for delaying senescence of postharvest fruit and vegetable.

**Keywords:** Electrospinning, methyl jasmonate, perishable crops
Whey protein incorporated with olive oil as novel edible coating for fresh-cut pineapple

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Abstract

Nowadays, the market for fresh ready-to-eat or fresh-cut products has increased explosively due to the increasing consumer demand for fresh produce as an important source of nutrients, vitamins and fiber and also convenient. At the same time, the major problems of fresh-cut industry are cutting surface browning, weight loss and short shelf-life. Thus, this study aimed to maintain the postharvest quality of fresh-cut pineapple using whey protein incorporated with olive oil as edible coating. Pineapple fruits cv. Pattavia with commercial maturity were washed and cut longitudinal section with thickness of 2-3 cm (about 70-85 g each). Coating solutions consist of 10% whey protein isolate (WPI) mixed with olive oil at the concentrations of 0, 0.25, 0.5, and 1%. Fruit sticks were dipped into composite coating solutions for 2 min and dried at 25°C for 1 h. All samples were packed in a polypropylene (PP) boxes and stored at 4°C. WPI + 1% olive oil significant reduced weight loss and maintained the highest levels of ascorbic acid contents and total phenolic contents of fresh-cut pineapple. In addition, edible coating delayed ripening. However, edible coatings did not affect firmness and malondialdehyde content.

Keywords: Antioxidant, postharvest quality, ready-to-eat, ripening, weight loss
Changing of antioxidant activity of butterfly pea flower in modified atmosphere packaging

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Abstract
Currently consumers give more attention in antioxidant capacity of fresh fruit and vegetables. Demand for fresh fruit and vegetables increased especially those with high anthocyanin contents. In Thailand, butterfly pea flower (*Clitoria ternatea*) is a one of flower vegetables that have a high nutritive value and also has a high antioxidant activity. Effect of modified atmosphere packaging were studied their effect on antioxidant activities. Butterfly pea flowers were obtained from Chiangrai Province, Thailand to Postharvest Technology Laboratory, Mae Fah Luang University. Then all samples were sorted without defects before packed with PP, PE, OPP and paper bag. Then all samples were stored at 5°C. The results showed that butterfly pea flowers were packed with PP, PE and OPP bags had fresh weight, total anthocyanin and total phenol contents, DPPH scavenging activity and FRAP value higher than paper bag. Moreover, shelf life of butterfly pea flowers packed with PP, PE and OPP had the longest shelf life with 8 days.

Keywords: Modified atmosphere packaging, antioxidant activity, butterfly pea flower
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**Effect of Hot Water Treatment and Prochloraz on the Postharvest Quality of `Carabao´ Mango**

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**Abstract**

`Carabao´ mango is a top Philippine mango variety for export, but it is highly susceptible to postharvest diseases. We evaluated the efficacies of hot water treatment (HWT) and prochloraz fungicide to control postharvest diseases in `Carabao´ mango. The treatments included HWT alone (52-55 ºC HWT dip, 5 min; 52-55 ºC HWT dip, 10 min + 10 min hydrocooling; HWT spray 52-55 ºC, 30 sec), fungicide alone (prochloraz spray, 550 µL L⁻¹, 30 sec; ambient prochloraz dip, 550 µL L⁻¹, 5 min) and the combination of two treatments (52-55 ºC HWT + 550 µL L⁻¹ prochloraz, 30 sec spray; 52-55 ºC HWT+ 550 µL L⁻¹ prochloraz, 5 min dip). Hot water treatments resulted in higher weight loss of fruit. It also hastened fruit ripening as indicated by rapid peel color change, increased total soluble solids and fruit softening. Fruit dipped in hot water alone (5 and 10 mins), and prochloraz alone for 5 min showed good quality for up to 9 days. Better quality of mango fruit was maintained by heated fungicide for 5 min (HWT, 52-55 ºC+ prochloraz, 550 µL L⁻¹) resulting in a longer shelf life of up to 20 days. With no symptoms of diseases, this treatment inhibited the development of stem end rot and anthracnose. Hot water treatment alone controlled stem end rot, while prochloraz alone showed inhibition of anthracnose. Combining HWT and prochloraz inhibited the development of stem end rot and anthracnose in `Carabao´ mango.

**Keywords:** Anthracnose, fungicide, heat treatment, shelf life, stem end rot
Salicylic acid as alternative treatment for Sulfur dioxide to control rot incidence and improves the quality of cold stored 'Flame Seedless' grapes

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Abstract
The grapes suffer from some of the problems of export and supply, the most important of which is the rot incidence, water loss, rachis browning and berry shattering. Sulfur dioxide (SO₂) is used commercially either by fumigation or releasing pads to prevent the growth of Botrytis cinerea rot during trading and storage but alternative methods are needed to avoid SO₂ residues. The present study has been focused on the reduction of SO₂ application by using salicylic acid (SA) as natural and safe antimicrobials. Grapes (Vitis vinifera L. cv. Flame seedless) clusters were treated with one of the following treatments: distilled water (control), sulphur dioxide (SO₂), 1mM/L SA and 2mM/L SA. Afterward, the clusters were air dried, randomly packed in perforated (4% ventilation) plastic punnets (weight approximately 450 g), put in carton boxes, cooled and stored at 0°C and 95% relative humidity (RH). After 10, 20 and 30 days of storage a group of each treatment was transferred to shelf-life for 2 days at 20°C and then evaluated. The results showed that SA at concentration of 2mM/L reduced rot incidence, weight loss, rachis browning and berry shattering up to 20 days at 0°C plus two days shelf-life at 20°C.

Keywords: Table grapes, rot incidence, browning, postharvest, salicylic acid
Ascorbic acid as alternative treatment for sulfur dioxide to control rot incidence and keeping the quality of 'Flame Seedless' grapes during short supply chain

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Abstract
The grapes suffer from some of the problems of export and supply, the most important of which is the rot incidence, water loss, rachis browning and berry shattering. Sulfur dioxide (SO$_2$) is used commercially either by fumigation or releasing pads to prevent the growth of Botrytis cinerea rot during trading and storage, but alternative methods are needed to avoid SO$_2$ residues. The present study has been focused on the reduction of SO$_2$ application by using ascorbic acid (AA) as natural and safe antimicrobials. Grapes (Vitis vinifera L. cv. Flame Seedless) clusters were treated with one of the following treatments: distilled water (passive control), dual release SO$_2$ pad (positive control), 1 mM L$^{-1}$ AA and 2 mM L$^{-1}$ AA. Afterward, the clusters were air dried, randomly packed in perforated (4% ventilation) plastic punnets (weight approximately 450 g), put in carton boxes, cooled, and stored at 0°C with 95% relative humidity (RH). After 10, 20 and 30 days of storage a group of each treatment was transferred to shelf-life for 2 days at 20°C and then evaluated. Rot incidence, weight loss, berry shattering, total postharvest losses (TPL), berry firmness, rachis browning index (BI), visual appearance index (AI), berry colour hue angle (h°), total soluble solids (TSS) total acidity (TA), anthocyanins, total phenolics (TP) content and respiration rate were estimated. The results showed that SO$_2$ and AA treatments showed significant benefits compared to the passive control and there were an added benefits by increasing AA concentration from 1 mM L$^{-1}$ to 2 mM L$^{-1}$ throughout the storage periods. Compared to the passive control, AA at concentration of 2 mM L$^{-1}$ reduced rot incidence, weight loss, BI, berry softening and berry shattering up to 20 days at 0°C plus two days shelf-life at 20°C. Up to 10 days storage plus 2 days shelf-life, both SO$_2$ and 2 mM L$^{-1}$ AA treatments were statistically equal regarding berry firmness, rot incidence, berry shattering, TPL, BI, AI, h°, TSS, TA, anthocyanins and TP contents. By extending the storage period, although SO$_2$ increased berry shattering but it showed superiority in rot control, AI, h° and reducing both TPA and respiration rate compared to all treatments. This result suggested that it could be recommended to use postharvest application of 2 mM L$^{-1}$ AA as alternative treatment for SO$_2$ to control rot, reduce TPL and keeping the quality of Flame Seedless grapes during short supply chain at 0°C with 95% RH for 1-2 weeks plus two days shelf-life at 20°C.

Keywords: Table grapes, rot incidence, browning, post-harvest, ascorbic acid
Control of Quality and Manage of Rot Disease by Using Coating and Temperature controlling for ‘Nam Dok Mai Sithong’ Mango

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Abstract

Mango (Mangifera indica L.) cv. Nam Dok Mai Sithong is the economic fruit of Thailand. However, the mango production is faced with the problem of fruit rot disease. The objective of this study was to investigate the effects of coating and temperature controlling on quality and postharvest disease of mango cv. Nam Dok Mai Sithong. Experiment was conducted based on a 6 × 2 factorial in a completely randomized design. DI water at 42 °C served as the control. Mango were separately dipping into 1.5%, 2% of chitosan and 20%, 25% of carnauba wax. All treatments inoculated with Lasiodiplodia theobromae and 2 storage temperature (10 and 25 °C) were used. Samples were randomly collected every 3 days. The skin and flesh color changes of mango was expressed as L*, a* and b* values. This value was increased gradually during storage both in skin and flesh mango indicating the color changed from green to yellow. The amounts of soluble solids tended to increase. In contrast, the amount of titrated acid was reduced. In addition, disease incidence was found in Nam Dok Mai Sithong to show symptoms after harvesting. Mango cv. Nam Dok Mai Sithong coated with 20% carnauba wax reduced disease incidence and extended shelf life up to 12 days under 10 °C. While mango dipped in 42 °C DI water (control) kept at 25 °C had storage life for 9 days.

Keywords: Nam Dok Mai Sithong, chitosan, carnauba, Lasiodiplodia theobromae
UV-C irradiation suppressed mycelial growth and increased antioxidant properties and jasmonic acid in mandarin fruit

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Abstract
UV-C irradiation at low doses has been reported to stimulate the production of secondary metabolites in various fruits. In this study, the effects of postharvest UV-C treatments on DPPH levels, total phenolic concentration, superoxide dismutase enzyme activity (SOD), jasmonic acid concentration and disease development in mandarins (Citrus reticulata cv. Sai Nam Phung) were investigated. Both UV-C treatments (5 kJ m⁻² and 10 kJ m⁻²) retarded mycelial growth in vitro and mycelial density in fruit exposed to 10 kJ m⁻² UV-C compared to that in control fruit. The levels of DPPH, total phenolic concentration and jasmonic acid concentration increased significantly (P < 0.05) during the first 24 h in the UV-C treated fruits compared to the control. The SOD activity of the UV-C treated samples was higher than those of the control. These results indicate that UV-C irradiation of 5 and 10 kJ m⁻² has a direct germicidal effect and induces a change in bioactive compounds and jasmonic acid concentration, which may disrupt the development of Penicillium spp.

Keywords: Bioactive compounds, Citrus reticulata, Penicillium spp., ultraviolet radiation
Effect of *Beauvaria bassiana* and wood vinegar to moth larvae pest and quality of plant in sacred lotus (*Nelumbo lucifera*)

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Abstract

Moth larvae is the serious pest of sacred lotus (*Nelumbo lucifera*). They destroy leaves and flowers in the lotus field which affect the quality of lotus before harvesting. Small larvae which attach in some cutting leave of lotus continue causing the wound and cause a short post harvesting time after cutting. This work aims to investigate the efficiency of two biopesticides, wood vinegar and entomopathogenic fungi (*Beauveria bassiana*) against moth larvae in the field before harvesting. The results showed that *B. bassiana* has the efficiency to kill moth larvae without the effect of lotus leaf product, whereas wood vinegar was not. Small dose of wood vinegar was not any effect to moth larvae, but the high dose (>20 ml/l) cause a brown spot on the leave which effect the product quality.

Keywords: Biopesticide, moth, entomopathogenic fungi