UNIVERSITI PUTRA MALAYSIA

EFFECTS OF HOT WATER DIP TREATMENT ON PHYSICOCHEMICAL CHARACTERISTICS, ANTHRACNOSE (Colletotrichum musae) CONTROL AND ENZYMATIC ACTIVITY OF BERANGAN BANANA (Musa sapientum L.) DURING RIPENING

AMIN MIRSHEKARI

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By

AMIN MIRSHEKARI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

September 2012

DEDICATION

This thesis is dedicated to all I love specially

To the soul of my parents, my beloved mother and father

In the heaven who regretfully did not live to see this work.

To my beloved wife Aazam, my daughters, Delara and Sara

For the unconditional patience, love and support.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

EFFECTS OF HOT WATER DIP TREATMENT ON PHYSICOCHEMICAL CHARACTERISTICS, ANTHRACNOSE (*Colletotrichum musae*) CONTROL AND ENZYMATIC ACTIVITY OF BERANGAN BANANA (*Musa sapientum L.*) DURING RIPENING

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AMIN MIRSHEKARI

September 2012

Chairperson: Phebe Ding, PhD

Faculty: Agriculture

Banana, as an important export fruit, is a highly perishable commodity. Postharvest rot is the major factor limiting the extension of storage life of banana. The beneficial effect of heat treatment to control decay and prolong the shelf life has been reported on various fruits. To achieve the best combination of water temperature and dipping time, Berangan banana fruit was treated with water at 25 (control), 45, 50 and 55 ºC for 10, 20 and 30 min.

The results obtained in the first experiment showed that fruit firmness, peel and pulp colour (hº) increased significantly, while respiration rate, ethylene production, peel and pulp colour (L* and C*), soluble solids concentration (SSC), titratable acidity (TA) and pH decreased significantly when hot water temperature and dipping time increased. Hot water of 45 ºC for 10 and 20 min dipping time did not show any significant difference in fruit quality as

compared to control. Hot water dip treatment of 45 ºC for 30 and 55 ºC for 10 min retarded some of fruit ripening processes in Berangan banana. The low respiration rate, ethylene production, peel and pulp colour (L*, C* and hº), SSC, TA and pH, and high firmness in Berangan banana treated with hot water of 50 ºC for 10 and 20 min indicated that this combination treatment could delay fruit ripening. Fruit dipped in hot water of 50 ºC for 30 min and 55 ºC for 20 and 30 min illustrated slight to severe peel blackening and suppressed ripening process in Berangan banana.

For anthracnose control, fruit was treated with hot water at 50 ºC for 0, 10 and 20 min without or with fungicide. The results clearly demonstrated that hot water without or with fungicide reduced severity of anthracnose in inoculated Berangan banana. Spore germination of *Colletotrichum musae* was suppressed completely with hot water of 50 ºC in 10 and 20 min without or with fungicide. Anthracnose symptoms did not develop in fruits dipped with hot water at 50 ºC for 20 min either with or without fungicide during 7 days of ripening.

The results of enzymatic activity experiment indicated that hot water dip at 50 ºC for 10 and 20 min could decrease cell wall degrading enzymes activity such as polygalacturonase (PG), pectin methylesterase (PME) and pectate lyase (PL) of Berangan banana fruit. The scanning electron microscope (SEM) micrographs showed that hot water dip at 50 ºC for 10 and 20 min could melt the fruit epicuticular waxes, so that it covered and sealed the microscopic cracks on the fruit surface. The results of ultrastructural

investigation indicated that hot water of 50 ºC for 20 min has lesser loss of cell rigidity and dissolution of cell wall pectin fractions of tissues in Berangan banana. It can be concluded that hot water dip treatment using 50 ºC for 10 min showed reasonable delay of fruit ripening and anthracnose control as compared to other combination of temperature and dipping time. This combination of temperature and dipping time could be the most possible to be used as a commercial treatment in extending the shelf life of Berangan banana for local consumption and export purposes.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN RAWATAN AIR PANAS KE ATAS SIFAT FIZIKOKIMIA, KAWALAN ANTRAKNOS (*Colletotrichum musae*) DAN AKTIVITI ENZIM PISANG BERANGAN (*Musa sapientum L.*) SEMASA PERANUMAN

Oleh

AMIN MIRSHEKARI

September 2012

Pengerusi: Phebe Ding, PhD

Fakulti: Pertanian

Pisang adalah satu komoditi eksport yang penting dan sangat mudah rosak. Reput lepas tuai adalah faktor utama yang menghadkan pemanjangan hayat penyimpanan pisang. Kelebihan rawatan haba dalam mengawal pereputan dan memanjangkan jangka hayat telah dilaporkan untuk pelbagai jenis buah-buahan. Untuk mencapai kombinasi yang terbaik antara suhu air dan masa rendaman, buah pisang Berangan dirawat dengan air pada suhu 25 (kawalan), 45, 50 dan 55 ºC selama 10, 20 dan 30 minit.

Keputusan yang diperoleh dalam kajian pertama menunjukkan bahawa kekerasan, warna kulit dan isi (hº) buah meningkat secara signifikan, manakala kadar respirasi, penghasilan etilena, warna kulit dan isi (L* dan C*), kandungan pepejal terlarut (SSC), asid tertitrat (TA) dan pH menurun secara signifikan apabila suhu air panas dan masa rendaman meningkat. Air panas bersuhu 45 ºC dan masa rendaman selama 10 dan 20 minit, tidak menunjukkan sebarang perbezaan yang signifikan berbanding dengan

kawalan. Rawatan rendaman air panas 45 ºC selama 30 minit dan 55 ºC selama 10 minit merencatkan beberapa proses peranuman buah pisang Berangan. Kadar respirasi, penghasilan etilena, warna kulit dan isi (L *, C* dan hº), kandungan pepejal terlarut, asid tertitrat, pH dan kekerasan adalah rendah pada buah pisang Berangan yang dirawat dengan air panas bersuhu 50 ºC selama 10 dan 20 minit. Ini menunjukkan bahawa gabungan rawatan ini berupaya melambatkan peranuman buah. Buah yang direndam di dalam air panas bersuhu 50 ºC selama 30 minit dan 55 ºC selama 20 dan 30 minit menyebabkan sedikit sehingga banyak penghitaman warna kulit dan mengganggu peranuman buah pisang Berangan.

Untuk kawalan antraknos, buah telah dirawat dengan air panas pada suhu 50 ºC selama 0, 10 dan 20 minit tanpa atau dengan racun kulat. Keputusan jelas menunjukkan bahawa rawatan air panas tanpa atau dengan racun kulat mengurangkan keseriusan antraknos pada buah pisang Berangan yang telah diinokulasi. Percambahan spora *Colletotrichum musae* telah dihalang sepenuhnya oleh air panas bersuhu 50 ºC selama 10 dan 20 minit tanpa atau dengan racun kulat. Simptom antraknos juga tidak dapat dilihat pada buah yang dicelup dengan air panas bersuhu 50 ºC selama 20 minit sama ada dengan atau tanpa racun kulat selama 7 hari peranuman.

Keputusan eksperimen aktiviti enzim menunjukkan bahawa rendaman air panas pada suhu 50 ºC selama 10 dan 20 minit boleh mengurangkan aktiviti enzim pada dinding sel seperti poligalakturonase (PG), metilesterase pektin (PME) dan pektat liase (PL) pada buah pisang Berangan. Mikrograf daripada

mikroskopi pengimbas elektron (SEM) menunjukkan bahawa rendaman air panas pada suhu 50 ºC selama 10 dan 20 minit boleh mencairkan lapisan lilin buah epicuticular, dan ia melitupi retakan mikroskopik yang terdapat pada permukaan buah. Keputusan kajian ultrastruktur menunjukkan bahawa rendaman air panas bersuhu 50 ºC selama 20 minit dapat mengekalkan ketegaran sel dan pelarutan pektin dinding sel pada buah pisang Berangan. Kesimpulannya, rawatan rendaman air panas menggunakan suhu 50 ºC selama 10 minit dapat menangguhkan peranuman buah pisang dan mengawal antraknos berbanding dengan kombinasi suhu dan masa rendaman yang lain. Ia boleh dijadikan kemungkinan yang terbaik untuk digunakan sebagai rawatan komersial bagi melanjutkan jangka hayat buah pisang Berangan untuk tujuan kegunaan tempatan dan eksport.

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I certify that a Thesis Examination Committee has met on 3th September 2012 to conduct the final examination of Amin Mirshekari on his thesis entitled "Effects of Hot Water Dip Treatment on Physicochemical Characteristics, Anthracnose (*Colletotrichum musae*) Control and Enzymatic Activity of Berangan banana (*Musa sapientum L.*) During Ripening" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy. Members of the Thesis Examination Committee were as follows:

Izham Ahmad, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Mahmud Tenku Muda Mohamed, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Lau Wei Hong, PhD
Senior Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Chien Y. Wang, PhD
Associate Professor
Laboratory of Food Quality
Unated State Department of Agriculture (USDA)
(External Examiner)

SEOW HENG FONG,PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

PHEBE DING, PhD
Senior Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Chairperson)

JUGAH KADIR, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

HASANAH MOHD GHAZALI, PhD
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT,PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

AMIN MIRSHEKARI

Date: 3 September 2012

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