EFFECTS OF POSTHARVEST HOT WATER TREATMENT ON PHYSIOLOGICAL AND BIOCHEMICAL PROPERTIES OF EKSOTIKA II PAPAYA DURING RIPENING

ARINA BINTI MHD ARSHAD

FACULTY OF SCIENCE
UNIVERSITY OF MALAYA
KUALA LUMPUR

2011

EFFECTS OF POSTHARVEST HOT WATER TREATMENT ON PHYSIOLOGICAL AND BIOCHEMICAL PROPERTIES OF EKSOTIKA II PAPAYA DURING RIPENING

ARINA BINTI MHD ARSHAD

DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

INSTITUTE OF BIOLOGICAL SCIENCES
FACULTY OF SCIENCE
UNIVERSITY OF MALAYA
KUALA LUMPUR

2011

Abstract

The effects of postharvest hot water treatment (HWT) on the quality of 'Eksotika II' papaya fruit harvested at different harvesting maturities were investigated. HWT is a method for fruit fly disinfestation which is a quarantine requirement for the fresh papaya exportation industries in Malaysia. Fruit at maturity stages Index 1 (H1), Index 2 (H2) and Index 3 (H3) were harvested. From each maturity stage, one group of the papaya fruit batch was treated with hot water at 47±1˚C fruit core temperature held for 10 minutes and another group was untreated. Fruit were left to ripen at ambient temperature (25˚C) and were taken into experiment at the subsequent ripening stages at Index 2, Index 3, Index 4 and Index 5. Physiological changes including skin colour (L*a*/b*), weight loss, fruit firmness, total soluble solids (TSS), pH and chlorophyll fluorescence were determined at each different ripening stages. Biochemical changes including total sugar, total reducing sugar, total non-reducing sugar and cell wall degrading enzymes activities such as polygalacturonase (PG), pectin methylesterase (PME), pectate lyase (PL) and cellulase were also investigated. HWT did not give any significantly adverse effect to the physiology parameters evaluated, such as L*a*/b* value, weight loss, TSS and pH. However, the treated Index 3 and Index 4 of H1 fruit was slightly firmer than the untreated fruit. The chlorophyll fluorescence parameters have shown that within one hour after treatment, the treated fruit experienced heat stress which was reflected in the lower chlorophyll fluorescence parameters values, Fv/Fm. The heat stress was found to be more severe by 14 – 25 % in the H3 fruit rather than in the H2 and H1 fruit. However, the Fv/Fm value in the H3 fruit recovered by 25% during the subsequent stages of ripening. Furthermore, the total sugar and the total reducing sugar content were not adversely affected by the HWT. The pattern of cell wall degrading enzymes activity showed that PME activity decreased during ripening, whilst PG, PL and cellulase activity increased progressively during ripening. It was also found

that the application of the HWT affected the cell wall degrading enzymes activity whereby it was found to be lower in the heat treated fruit. Nevertheless, pulp firmness was not severely affected since some of the enzyme activities managed to recover during the ripening period. For maximum fruit quality, particularly for export markets, it is recommended that Index 2 fruit are selected for HWT rather than H1 fruit since the H1 fruit will ripen poorly. The Index 3 Eksotika II papaya is only suitable for the local market because of its short shelf life. In summary, these observations indicated that the overall Eksotika II papaya fruit quality is still maintained following HWT when the fruit is allowed to ripen at ambient temperature. This suggests that postharvest HWT at 47 °C (fruit core temperature, held for 10 minutes) can maintain the postharvest quality of Eksotika II papaya fruit.

Abstrak

Kesan – kesan rawatan air panas lepas tuai terhadap kualiti buah betik ‘Eksotika II’ yang dituai pada pada tahap kematangan yang berbeza telah dikaji. Rawatan air panas adalah salah satu kaedah untuk membasmi lalat buah yang merupakan satu keperluan kuarantin yang perlu dipatuhi oleh industri pengeksportan betik di Malaysia. Buah dituai pada tahap kematangan Indeks 1 (H1), Indeks 2 (H2) dan Indeks 3 (H3). Satu kumpulan daripada buah yang dituai pada setiap tahap kematangan yang berbeza dirawat dengan air panas sehingga teras buah mencapai suhu 47±1˚C dan suhu tersebut dikekalkan selama 10 minit. Manakala, satu lagi kumpulan buah tidak dirawat dan digunakan sebagai kawalan. Kemudian, kesemua buah tersebut dibiarkan melalui proses pemasakan pada suhu bilik (25˚C) dan diambil untuk eksperimen pada setiap tahap pemasakan yang berlaku seterusnya iaitu pada tahap pemasakan Indeks 2, Index 3, Indeks 4 dan Indeks 5. Perubahan – perubahan fisiologi yang meliputi perubahan warna kulit buah (L*a*/b*), kehilangan berat, tahap kekerasan buah, jumlah bahan larut (TSS), pH dan sinaran berpendarfluor klorofil telah dikenalpasti pada setiap tahap pemasakan. Perubahan – perubahan biokimia termasuklah jumlah keseluruhan gula, jumlah gula penurun, jumlah gula bukan penurun dan aktiviti enzim-enzim yang terlibat dalam penceraian struktur dinding sel seperti poligalakturonase (PG), pektin metilesterase (PME), pektate lyase (PL) dan cellulase juga telah dikaji. Rawatan air panas tidak memberikan kesan tidak baik yang signifikan terhadap faktor – faktor fisiologi yang dikaji seperti nilai L*a*/b*, kehilangan berat buah, TSS dan pH. Walaubagaimanapun, buah H1 pada Indeks 3 dan 4 yang dirawat dengan air panas adalah lebih keras berbanding dengan buah pada Indeks yang sama yang tidak dirawat. Parameter sinaran berpendarfluor klorofil menunjukkan bahawa dalam masa satu jam selepas rawatan, buah yang dirawat mengalami tekanan yang disebabkan oleh suhu tinggi. Kesan ini boleh dilihat dari nilai Fv/Fm yang rendah. Tekanan yang disebabkan oleh suhu tinggi

ini adalah lebih ketara (14 – 25 %) pada buah yang lebih masak iaitu H3 berbanding buah yang kurang masak iaitu H2 dan H1. Walaubagaimanapun, nilai Fv/Fm ini pulih kembali sebanyak 25 % apabila melalui proses pemasakan yang seterusnya. Disamping itu, kandungan keseluruhan gula dan gula penurun tidak dipengaruhi oleh rawatan air panas yang dijalankan. Corak aktiviti enzim – enzim yang terlibat dalam proses penceraian struktur dinding sel menunjukkan bahawa aktiviti PME menurun semasa proses pemasakan, manakala aktiviti enzim – enzim PG, PL dan cellulase meningkat sepanjang proses pemasakan. Rawatan air panas memberi kesan terhadap aktiviti enzim – enzim ini dimana aktiviti enzim – enzim tersebut adalah lebih rendah didalam buah yang dirawat dengan air panas. Walaubagaimanapun, kekerasan buah tidak dipengaruhi oleh keadaan ini kerana ada diantara aktiviti enzim – enzim ini telah kembali pulih semasa proses pemasakan. Untuk kualiti buah yang maksimum, khasnya untuk pasaran eksport, adalah dicadangkan bahawa buah dituai pada tahap kematangan Indeks 2 untuk rawatan air panas, memandangkan buah yang dituai pada Indeks 1 (H1) tidak akan masak dengan sempurna. Manakala buah yang dituai pada Indeks 3 (H3) hanya sesuai untuk pasaran tempatan kerana jangka hayatnya yang pendek. Kesimpulannya, keputusan kajian ini menunjukkan bahawa kualiti buah betik ‘Eksotika II’ secara keseluruhannya dikekalkan walaupun selepas rawatan air panas apabila buah tersebut dibiarkan melalui proses pemasakan pada suhu bilik. Ini menunjukkan bahawa rawatan air panas lepas tuai pada suhu 47 °C (suhu teras buah yang dikekalkan selama 10 minit) dalam kajian ini dapat mengekalkan kualiti lepas tuai buah betik Eksotika II.

Acknowledgements

First and foremost, all praise to Allah, the Almighty, the most Gracious and the most Merciful, for His blessings and for giving me mental and physical strengths to complete this project.

I would like to express my deepest gratitude to both of my respected supervisors, Professor Dr. Amru Nasrulhaq Boyce and Dr. Chandran Somasundram for their invaluable guidance and advice throughout this study. Thanks are also expressed to Dr. Tung Heng Fong for her continuous assistance and guidance that helped me a lot to complete this study. I also would like to thank Prof. Helen Nair for her invaluable guidance and advice during the study period. I am also greatly indebted to Puan Zam Abdul Karim, for her assistance in finding the source for the papaya sample in this study. Many thanks to Encik Johari from DOA, Encik Harry Aziz from Exotic Star and Encik Rahim who provided papaya sample throughout my work. To all my friends of Postharvest Biotechnology Laboratory : Punitha, Wei Lim, Daniel, Wijenthiran, Zuliana, Kit Yew Sen, Loo Zhang Xin, Rebecca, Nadiah, Jasmine and Mr. Doraisamy, thank you very much for giving me courage and technical supports during this project.

A very sincere gratitude to my beloved father and mother, parents in law, brothers, sisters and all family members for their unconditional support and love in completing this project. Finally, a very special thanks goes to my beloved husband, Mohd Akhbar Ismail, for his love, care and support during the entire study period. Without the assistance of the people mentioned above, this study would have never reach completion.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ASEAN	Association of South-East Asian Nations
cm	Centimetre
CMC	Carboxymethylcellulase
ddH_2O	Double distilled water
dH_2O	Distilled water
DMRT	Duncan Multiple Range Test
DOA	Department of Agriculture, Malaysia
et al.	*et alia* (and others)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
Fm	Maximum fluorescence yield
Fo	Minimum fluorescence yield
Fv	Variable fluorescence yield (Fv = Fm – Fo)
Fv/Fm	Optimum quantum yield of photosystem II
FW	Fresh weight
g	Gram
GA	Galacturonic acid
H1	Eksotika II papaya fruit harvested at Index 1
H2	Eksotika II papaya fruit harvested at Index 2
H3	Eksotika II papaya fruit harvested at Index 3
HSP	Heat shock proteins
HWT	Hot water treatment
Kgf	Kilogram force
m	Metre

M	Molar
MARDI	Malaysian Agricultural Research and Development Institute
mg	Milligram
µg	Microgram
µM	Micromolar
µmol	Micromoles
ml	Millilitre
mM	Milimolar
mm	Millimetre
PG	Polygalacturonase
PL	Pectate lyase
PME	Pectin methylesterase
PRSV	Papaya Ringspot Virus
RT	Room temperature
SPS	Sanitary and Phytosanitary
TSS	Total soluble solids
UDP	Uridine diphosphate
UK	United Kingdom
UTP	Uridine triphosphate
USA	United States of America

List of Appendices