UNIVERSITI PUTRA MALAYSIA

POSTHARVEST QUALITY OF RED PITAYA (*Hylocereus polyrhizus*) AS AFFECTED BY HARVEST DATE, STORAGE DURATION AND 1-METHYLCYCLOPROPENE

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By

MELLY NOVITA

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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This thesis is especially
dedicated to my beloved:

Bunda Cut Dian Faridah,……
Cut bang Hery, Cut anda Ira, Bang Yan and my love

For love, sacrifices and support

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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MELLY NOVITA

April 2008

Chairman : Associate Professor Siti Hajar Ahmad, PhD

Faculty : Agriculture

Pitaya is a non-climacteric fruit, so it has to be harvested at the optimum edible stage of maturity. The maturity at harvest greatly influences the eating quality and storage life of fruits. Storage of pitaya more than 7 days at ambient temperature causes scales shriveling and degreening, and peel and pulp softening resulting in reduced quality. Little information is available on optimum harvest date and storage method for pitaya. In this study, the first experiment was to determine harvest date using growth and physico-chemical changes of red pitaya up to 40 days after anthesis (DAA). When fruit growth, as indicated by increment in diameter, length and weight, remained constant from 25 to 40 DAA, physico-chemical changes started to occur. Peel and pulp turned vivid purple followed by decreased firmness, acidity and ascorbic acid content of pulp while soluble solids concentration and pH increased.

The second experiment was carried out to determine the effects of harvest date and 1-MCP during 28 days of storage on physico-chemical changes of red pitaya.

Fruits were harvested at 30 and 35 DAA and treated with 0, 250, 500, 750 and 1000 nL/L 1-MCP for 4 h at ambient temperature and then stored for 28 days at 10 ^{o}C. There were linear increases in water loss but linear decreases in pulp firmness of both 30 and 35 DAA harvested fruits during 28 days of storage. L* and C* colour values of fruits from both harvest dates changed to produce vivid purple peel during the storage period. Fruits harvested at 30 DAA had slower increase in sugar:acid and pH during storage compared to fruits harvested at 35 DAA. Ascorbic acid and betacyanin content of fruits harvested at 35 DAA showed decreasing quadratic trend during storage, while phenolic content had a linear decrease. Fruits harvested at 35 DAA had linear increases in ascorbic acid and phenolic content when treated with increasing 1-MCP concentration, while betacyanin content had a quadratic increase during 28 days of storage. Fruits harvested at 30 DAA had 33% more CO_2 at 0 day of storage compared to fruits harvested at 35 DAA. However, the trend of quadratic decrease in CO_2 production during storage duration in both harvested fruits was similar. There were no interaction effects of storage duration and 1-MCP on ethylene and CO_2 production of fruit from both harvest date.

Sugar:acid and pH of control and 250 nL/L 1-MCP treated fruits increased quadratically during storage, while ascorbic acid and phenolic content each had a quadratic decrease. Control fruits had linear decreases in both citric acid and betacyanin content during the 28 days of storage. Fruits treated with 500, 750 and 1000 nL/L 1-MCP showed a quadratic decrease in ascorbic acid during storage, while there was no effect of storage duration on betacyanin and phenolic

contents. Ethylene production of fruits treated with 500, 750 and 1000 nL/L 1-MCP was only detected after 14 days of storage. CO_2 production had a similar trend of quadratic decrease in all the 1-MCP treated fruits during the 28 days of storage.

In conclusion, physico-chemical characteristics of red pitaya started to change from 25 till 40 DAA i.e. towards the end of fruit growth period. Thus, the fruit could be harvested between 30 and 40 DAA. Quality reduction and senescence were delayed in fruits harvested at 30 DAA because conversion of acid to sugar was delayed. Antioxidants such as ascorbic acid, betacyanin and phenolic contents of fruits harvested at 30 DAA were not affected by storage duration. Fruits for both harvest dates could delay ethylene production during 14 days of storage with a minimum treatment of 500 nL/L 1-MCP, thus reducing respiration rate and delaying senescence.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN HARI PENUAIAN, TEMPOH PENYIMPANAN DAN RAWATAN DENGAN 1-METHYLCYCLOPROPENE TERHADAP KUALITI LEPAS TUAI PITAYA MERAH (*Hylocereus polyrhizus*)

Oleh

MELLY NOVITA

April 2008

Pengerusi : Professor Madya Siti Hajar Ahmad, PhD

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Kematangan buah semasa penuaian penting dalam mempengaruhi kualiti makan dan hayat penstoran bagi buah-buahan. Pitaya merupakan buah bukan klimakterik, oleh itu, ia perlu dituai pada peringkat kematangan dengan nilai pemakanan optimum. Penstoran buah pitaya lebih daripada 7 hari pada suhu ambient menyebabkan kulit dan isi buah berkedut, nyahhijau dan lembut seterusnya mengurangkan kualiti. Maklumat mengenai masa penuaian yang optimum dan kaedah penyimpanan buah pitaya masih berkurangan. Dalam kajian ini, eksperimen pertama yang dijalankan adalah untuk menentukan hari penuaian berasaskan pertumbuhan dan perubahan fizikal kimia buah pitaya merah sehingga 40 hari selepas antesis (HLA). Pada 25-40 hari selepas antesis, diameter, panjang dan berat buah masih kekal malar tetapi perubahan fisikal kimia mula berlaku. Kulit dan isi buah mula bertukar ke warna ungu. Keteguhan isi, keasidan dan kandungan asid askorbik menurun tetapi jumlah pepejal terlarut dan pH meningkat.

Eksperimen kedua dijalankan untuk menentukan kesan hari penuaian dan rawatan 1-MCP selepas 28 hari penstoran terhadap perubahan fisiko-kimia buah pitaya merah. Buah pitaya dituai pada 30 dan 35 hari selepas antesis dan dirawat dengan 0, 250, 500, 750 dan 1000nL/L 1-MCP selama 4 jam pada suhu ambient dan kemudian disimpan selama 28 hari pada suhu 10°C. Selepas 28 hari penstoran, kehilangan air bertambah secara linear sedangkan keteguhan isi berkurangan secara linear pada buah yang dituai 30 dan 35 hari selepas antesis. Nilai warna L* dan C* bertukar menyebabkan kulit buah yang dituai pada kedua-dua hari penuaian bertukar ke warna ungu. Buah yang dituai pada 30 HLA mempunyai peningkatan nisbah gula:asid dan pH yang rendah semasa penstoran berbanding 35 HLA. Kandungan asid askorbik dan betasianin dalam buah yang dituai pada 35 HLA menunjukkan pengurangan secara kuadratic sedangkan kandungan fenolic mempunyai peningkatan linear semasa penstoran. Peningkatan asid askorbik dan kandungan fenolic adalah secara linear pada buah dituai pada 35 HLA apabila dirawat dengan kepekatan 1-MCP yang semakin meningkat sementara kandungan betasianin meningkat secara kuadratic selama 28 hari penyimpanan. Buah yang dituai pada 30 HLA mempunyai 33% lebih CO_2 pada hari 0 penyimpanan berbanding dengan buah yang dituai pada 35 HLA. Walau bagaimanapun, trend kuadratik bagi pengurangan penghasilan CO_2 semasa penstoran adalah sama. Tiada interaksi bagi tempoh penyimpanan dan 1-MCP terhadap penghasilan etilena dan CO_2 bagi buah yang dituai pada 30 dan 35 HLA.

Gula:asid, kawalan pH dan rawatan 250 nL/L 1-MCP meningkat secara kuadratic semasa penstoran sementara asid askorbik dan kandungan fenolic menurun secara kuadratik. Bagi kandungan kedua-dua asid sitrik dan betasianin dalam buah kawalan menurun secara linear selepas 28 hari penstoran. Buah yang dirawat dengan 500, 750 dan 1000 nL/L 1-MCP menunjukkan penambahan kuadratik bagi asid askorbik semasa penstoran. Tiada kesan jangka penstoran terhadap kandungan betasianin dan fenolic. Penghasilan etilena pada buah yang dirawat dengan 500, 750 dan 1000 nL/L 1-MCP cuma dikesan selepas 14 hari penstoran. Penghasilan CO_2 adalah menurun secara kuadratic dalam semua buah yang dirawat dengan 1-MCP selepas 28 hari penstoran.

Kesimpulannya, buah pitaya memulakan perubahan ciri-ciri fisiko-kimia antara 25-40 HLA iaitu di akhir pertumbuhan buah. Oleh itu, buah boleh dituai pada 30-40 HLA. Pengurangan kualiti dan kesenesenan dilambatkan pada buah yang dituai pada 30 HLA akibat pertukaran daripada asid ke gula yang dilewatkan. Antioksidan seperti asid askorbik, betasianin dan kandungan fenolic bagi buah yang dituai pada 30 HLA tidak dipengaruhi oleh tempoh penyimpanan. Buah yang dituai pada HLA di atas dapat melambatkan penghasilan etilena dengan penstoran selama 14 hari bila dirawat dengan paras minima iaitu 500 nL/L 1-MCP. Ini dapat menurunkan kadar respirasi dan melambatkan kesenesenan.

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I certify that an Examination Committee met on 17th of march to conduct the final examination of Melly Novita on her Master of Science thesis entitled "Postharvest Quality of Red Pitaya (*Hylocereus polyrhizus*) as Affected by Harvest Date, Storage Duration and 1-Methylcyclopropene "in accordance with Universiti Pertanian Malaysia (High Degree) Act 1980 and Universiti Putra Malaysia (High Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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

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Date: 12 June 2008

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 at any other institutions.

MELLY NOVITA

Date: 23 April 2008

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AA	:	Ascorbic acid
ACC	:	1-aminocyclopropene-1-carboxylic acid
ACO	:	1-aminocyclopropene carboxylic acid oxidase
ACS	:	1-aminocyclopropene carboxylic acid synthase
AOA	:	Aminooxy acetic acid
AVG	:	Aminoethoxyvinylglycine
C*	:	Chromaticity
CA	:	Citric acid
C_2H_4	:	Ethylene
CO_2	:	Carbon dioxide
CRD	:	Completely randomized design
DAA	:	Days after anthesis
DACP	:	Diazocyclopentadiene
DMRT	:	Duncan's multiple range test
DPPH	:	2,2-diphenyl picryl hydrazil
EFE	:	Ethylene forming enzyme
FID	:	Flame ionization detector
GC	:	Gas chromatography
h	:	Hour
h^o	:	Hue
HPO_3	:	Metaphosphoric acid
L*	:	Lightness

LSD	:	Least significant difference
1-MCP	:	1-Methylcyclopropene
NaOH	:	Sodium hydroxide
ns	:	Non significant
PROC CORR	:	Procedure of correlation
PROC REG	:	Procedure of regression
r^2	:	Correlation coefficient
R^2	:	Regression coefficient
SAM	:	S-adenosyl methionine
SAS	:	Statistical analysis system
SSC	:	Soluble solids concentration
STS	:	Silver thiosulphate
TA	:	Titratable acidity
TCD	:	Thermal conductivity detector

CHAPTER 1

GENERAL INTRODUCTION

The red pitaya (*Hylocereus polyrhizus*), as it is commonly known in Latin America, is called dragon-fruit by the Asians (Mizrahi et al., 2002). This vine cactus species is native to tropical habitats in North and South America (Briton and Rose, 1963). The fruit size is a medium to large berry bearing large green or red scales. The pulp is not only delicate and juicy, but it is also high in natural antioxidants. It is also considered as a good source of vitamin C (Mizrahi et al., 2002).

Pitaya fruit has a good potential to be developed as an export crop. Since 2000, pitaya has been cultivated on a large scale in Malaysia as well as in other countries. Malaysia, with a tropical climate, has a big potential to develop pitaya as crop plant. The land planted with pitaya increased from 280 ha in 2004 to more than 2000 ha in 2006 (Pers.comm.). Since pitaya is an extremely perishable commodity, storage technology of pitaya will be needed to keep fruits in good condition before sale or consumption.

Pitaya is a non-climacteric fruit (Le et al., 2000), thus, it is not capable of continuing its ripening process if removed from the tree before it ripens. It has to be harvested at the right stage of maturity. If the fruit is harvested at an early stage of maturity it has poor eating quality, while if harvested at a late stage it has a short storage life (Harman, 1981; Kader, 1994). Fruit maturity is an important