UNIVERSITI PUTRA MALAYSIA

SUITABLE HARVESTING STAGE AND EFFECT OF 1-METHYCYCLOPROPENE ON POSTHARVEST QUALITY OF SOURSOP (Annona muricata L.)

LEM MING SIANG

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By

LEM MING SIANG

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

January 2018

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DEDICATION

To beloved my parents, sisters and little brother

To my friends as well

Without whom none of my success would be possible

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

SUITABLE HARVESTING STAGE AND EFFECT OF 1-METHYCYCLOPROPENE ON POSTHARVEST QUALITY OF SOURSOP (*Annona muricata* L.)

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January 2018

Chairperson : Mahmud Tengku Muda Mohamed, PhD
Institute : Tropical Agriculture and Food Security

Soursop (*Annona muricata* L.) known to be climateric fruit, rich in bioactive compounds for use in medicine, produce aromatic, sweet-sour and pleasantly tasting. There is, however, a limitation in reaching distant markets stems from quick ripening and accentuated softening that make fruits difficult to handle without damage and shortens postharvest life. In order to reduce lost in profits during storage life, this study aims to determine the optimum harvest stage and the effect of 1-Methylcyclopropene (1-MCP) treatment on postharvest life, physiological and physiochemical characterization of soursop. In the first experiment, soursop flowers were hand pollinated and tagged. Successful pollinated fruits were harvested from 12th weeks after pollination. Results showed that harvesting period from weeks 16 to 20 after pollination did not affect physicochemical quality such as respiration rate, ethylene production, soluble solids concentration, titratable acidity, ascorbic acid and pH for these fruits. Optimum harvest for soursop was indicated by peel colour change and decrease firmness which proximity with the physiological maturity along with maturity of seeds. Also, results indicated that soursop fruit start maturation and ripening from the distal part of fruit. In second experiment, fruits were harvested at 16th weeks after pollination selected for treated with various concentration of 1-MCP (0, 400, 800 and 1200 nL/L) at 15°C $\pm$ 3°C for 24 hours and then stored at ambient temperature (25°C $\pm$ 3°C). Observations on various physical, physiological, biochemical and antioxidants parameters were recorded at two days intervals during 6 days of storage. Result showed soursop treated at different 1-MCP concentration (0, 400, 800 and1200 nL/L) showed that fruit treated with 400 nL/L had better ripe fruit quality. In additional, 1-MCP treated fruits were able to normally soften at later ripening stage. However, antioxidant capacity, total phenolic content, and total flavonoid content of fruits from all treatments were found to be inconsistent during storage.

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

KESESUAIAN PERINGKAT PENUAIAN DAN APLIKASI 1-METHYCYCLOPROPENE TERHADAP KUALITI LEPAS TUAI DURIAN BELANDA (*Annona muricata* L.)

Oleh

LEM MING SIANG

Januari 2018

Pengerusi : Mahmud Tengku Muda Mohamed, PhD
Institut : Pertanian Tropika dan Sekuriti Makanan

Durian belanda (*Annona muricata* L.) dikenali sebagai buah klimaterik, kaya dengan sebatian bioaktif untuk digunakan dalam perubatan, mengeluarkan aroma, rasa manis-masam dan sedap. Walau bagaimanapun, terdapat limitasi untuk pemasaran yang jauh berpunca daripada kemasakan yang cepat dan buah lembik menyebabkan buah sukar ditangani tanpa kerosakan dan memendekkan jangka hayat lepas tuai. Dalam usaha untuk mengurangkan kehilangan keuntungan semasa penyimpanan. Kajian ini bertujuan untuk menentukan tahap penuaian optima dan kesan rawatan 1-metilsiklopropena (1-MCP) pada jangka hayat penyimpanan lepas tuai, fisiologi dan fisikokimia durian belanda. Dalam eksperimen pertama, pendebungaan berbantu telah dijalankan pada kuntum bunga yang sesuai dan ditanda. Buah yang berjaya didebungakan telah dituai pada minggu ke-12 selepas pendebungaan. Keputusan menunjukkan bahawa tempoh penuaian dari minggu ke-16 hingga 20 selepas pendebungaan tidak menjejaskan kualiti fizikokimia seperti kadar pernafasan, pengeluaran etilena, kepekatan pepejal larut, keasidan tertitrat, asid askorbik dan pH untuk buah durian belanda. Penuaian yang optimum untuk durian belanda berdasarkan oleh perubahan warna kulit dan pengurangan kekerasan isi, selaras dengan kematangan fisiologi bersama dengan biji buah mencapai kematangan. Keputusan juga menunjukkan bahawa buah durian belanda mula matang dan masak dari bahagian hujung buah. Dalam eksperimen kedua, buah-buahan dituai pada minggu ke-16 selepas minggu pendebungaan dan dirawat dengan pelbagai kepekatan 1-MCP (0, 400, 800 dan 1200 nL/L) pada 15°C $\pm$ 3°C selama 24 jam dan kemudian disimpan pada suhu ambien (25°C $\pm$ 3°C). Semasa penyimpanan, pelbagai parameter fizikal, fisiologi, biokimia dan antioksidan diperhatikan dan direkodkan selang dua hari. Buah durian belanda yang dirawat dengan kadar kepekatan 1-MCP yang berlainan (0, 400, 800 and1200 nL/L) menunjukkan bahawa buah yang dirawat dengan 400 nL/L mempunyai kualiti buah masak yang lebih baik. Selain itu, buah-

buahan yang dirawat 1-MCP dapat melembutkan sepenuhnya pada peringkat masak berikutnya. Walau bagaimanapun, keupayaan antioksidan, jumlah kandungan fenolik, dan jumlah kandungan *flavonoid* buah-buahan daripada semua rawatan didapati tidak konsisten semasa penyimpanan.

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Finally, my family members deserve special credit. My father, mother, two sisters and little brother have been a constant source of inspiration to me.

I certify that a Thesis Examination Committee has met on 10 January 2018 to conduct the final examination of Lem Ming Siang on her thesis entitled "Suitable Harvesting Stage and Effect of 1- Methycyclopropene on Postharvest Quality of Soursop (*Annona muricata* L.)" 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 Master of Science.

Members of the Thesis Examination Committee were as follows:

Yahya bin Awang, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Siti Zaharah binti Sakimin, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Zaulia Othman, PhD
Senior Lecturer
Malaysian Agricultural Research and Development Institute
Malaysia
(External Examiner)

RUSLI HAJI ABDULLAH, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 30 July 2018

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

Mahmud Tengku Muda Mohamed, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Phebe Ding, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

_____
ROBIAH BINTI YUNUS, PhD
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Signature:	_____
Name of Member of Supervisory Committee:	Associate Professor Dr. Phebe Ding

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LIST OF ABBREVIATIONS

%	Percentage
µm	Micrometer
°C	Degree Celsius
1-MCP	1-Methylcyclopropene
AsA	ascorbic acid
C*	chromaticity
C_2H_4	ethylene
CO_2	carbon dioxide
CRD	completely randomized design
DMRT	Duncan's multiple range test
DPPH	2,2-diphenyl-1-picrylhydrazyl free radical scavenging activity
g	Gram
GC	gas chromatography
h	Hour
h°	Hue
HPO_3	metaphosphoric acid
L*	lightness
mg	Milligram
min	Minute
mL	Millilitre
mm	Millimetre
Mt	Metric ton
N	Newton
NaOH	sodium hydroxide
ns	non significant
RH	relative humidity
RCBD	randomized completely block design
SAS	statistical analysis system
SSC	soluble solids concentration
TA	titratable acidity
TFC	total flavonoid content
TPC	total phenolic content
WL	weight loss

CHAPTER 1

INTRODUCTION

Soursop (*Annona muricata* L.), a members of the Annonaceae family, is a small evergreen tree widely cultivated from central America and is now widespread in the tropics and subtropics (Geurts, 1981). In Malaysia, soursop is still considered as a minor fruit crops, based on its only 356.7 hectare of cultivation with total yield of 1,470.4 Mt. (DOA, 2015) as compared to other fruits. At present, the fruit in Malaysia is mostly cultivated for domestic consumption. Nevertheless, it has great potentials to be developed commercially because of its inherent phytochemical for treatment of illnesses such as cancer and its other medicinal properties as health products. Furthermore, reasonable price at retail of soursop fruit also provides opportunity to growers for cultivation. Thus the fruit can be extensively cultivated in Malaysia to fulfil the foreseen demands from domestic and foreign markets.

The fruit size varies from medium to large with either ovoid, heart shaped or oblong syncarp that merged by several pistils and receptacles in creamy white pulpy structure with numerous black seeds embedded (Bueso, 1980; Worrell et al., 1994). Soursop fruits become more important exotic fruit due to its high nutrients, phytochemicals and biological properties such as acetogenins which are vital to maintain human health (Biba et al., 2014; Lim, 2012). Soursop is mostly eaten either fresh or in frozen pulp form because of its exotic taste, juicy flesh and aromatic when fully ripen (Badrie & Schauss, 2010).

Maturity index is one of the main factors which affect the postharvest storage and quality of soursop. To date there is no maturity index set up for soursop. Nevertheless, the most common indicators of maturity reported for soursop were determination by the changes of skin colour from dark green to light green (Accorsi & Manica, 1994; Pareek et al., 2011; Salunkhe & Desai, 1984 & Torres & Sanchez, 1992) the distance of their spurs; and degree of firmness of fruit surface which local growers usually tested by pressing each of the fruits before harvesting (Torres & Sanchez, 1992). Harvesting before physiologically matured will cause the soursop fruit does not ripen well and might lead to bitter taste pulp (Pareek et al., 2011; Torres & Sanchez, 1992). Thus, selective harvesting is commonly practiced by grower by virtue of its nonsynchronous fruit maturity on a tree.

Ethylene (C_2H_4) is natural plant hormone which controls a wide range of physiological processes in plants. In storage life of horticultural crops, ethylene affect senescence and, over-ripening, accelerated quality loss, increases fruit pathogen susceptibility, and physiological disorders (Saltveit, 1999; Watkins, 2002 & 2006). There are few ways to control the action of ethylene on ripening and senescence. Discovery of the inhibitor of ethylene receptor, 1-methylcyclopropene (1-MCP) for the use in extending postharvest shelf-life and maintaining quality of

horticultural crops has been reported (Blankenship & Dole, 2003; Sisler & Blankenship, 1996; Sisler & Serek, 1997). Huber (2008) in his studies of 1-MCP proved that most horticultural produce especially in climacteric fruit and those with very specific responses to exogenous ethylene gave positive response to this type of inhibitor. More than 100 studies have been conducted to investigate detail of its action, application and effects on ethylene inhibition including annona species such as custard apple (Benassi et al., 2003), sugar apple, cherimoya fruit (Li et al., 2009) and soursop (Espinosa et al., 2013; Moreno-Hernández et al., 2014).

The major bottlenecks in the local soursop value chain is the lack of improved postharvest technology as the crop is highly perishable when it becomes soft and easily bruised. As a typical climacteric fruit, soursop was characterized by a rapid increase in the rate of ethylene biosynthesis at the beginning of the ripening process (Bruinsma & Paul, 1984; Worrell et al., 1994). Presence of middlemen, known as collectors in the market chain that add no value to the produce and thus limit the potential of small scale processing factories or firms. Fruit quality deterioration are caused by several factors such as intrinsic characteristics of the fruit itself and storage condition. However, no research work has been reported relating to postharvest study on hand pollinated soursop at harvest stage and not to least, the effect of 1-MCP in extending its storage life, fruit softening and nutritional composition including ascorbic acid, antioxidant capacity and total phenolic content.

Hence, the main objective of this study was to observe the stage of fruit maturity and the effect of 1-MCP on postharvest quality of soursop. The specifics objectives were (i) to determine optimum harvest maturity in relation to its physiological and physiochemical characterization of soursop and (ii) to evaluate the effects of 1-MCP on delaying the ripening process in relation to the postharvest quality of soursop during storage period.

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