



UNIVERSITI PUTRA MALAYSIA

**PHYSICOCHEMICAL PROPERTIES OF WHOLE AND FRESH CUT
DURIAN (*Durio zibethinus*) STORED AT AMBIENT AND
REFRIGERATED TEMPERATURES**

VOON YIT YANG

FSTM 2008 17



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TEMPERATURES**

By

VOON YIT YANG

**Thesis submitted to the School of Graduate Studies, University Putra Malaysia, in
fulfillment of the Requirement for the degree of Doctor of Philosophy**

August 2008



DEDICATION

To my beloved grandmother, my parents, and Uncle Alan



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

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VOON YIT YANG

December 2007

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This study reports chemical changes occurring in the pulp of both whole and minimally processed (MP) durian (*Durio zibethinus*) stored at ambient and refrigerated temperatures. In the first part of this study, the pH, total soluble solids, titratable acidity, sugars, organic acids, flavour compounds and sensory properties of five Malaysian durian cultivars ('D2', 'D24', 'MDUR78', 'D101' and 'Chuk') were determined. There were significant differences in physicochemical characteristics among the cultivars. Analysis using solid-phase microextraction (SPME) coupled to gas chromatography-time of flight mass spectrometry (GC-TOFMS) revealed a total of 22 esters, 14 sulphur compounds, 7 alcohols, 3 aldehydes and 1 ketone in the pulp of the 5 durian cultivars. Sensory properties of four durian cultivars were compared. Twelve descriptors (sweet, fruity, sulphury, alcohol, nutty and green aroma, surface color, sweetness, bitterness,



stickiness, moistness and overall aftertaste) were generated. A strong correlation was observed between sensory properties, flavour compounds and physicochemical characteristics of the fruit.

In the second part of this study, activities of four cell wall hydrolases, pectinmethylesterase (PME), polygalacturonase (PG), cellulase and β -galactosidase (β -Gal) and physicochemical changes of ripen whole durian fruit (cultivar D24 and an accession from Kampung Bentong, Pahang) stored at 28 ± 1 °C (RH 60-80%) for 4 days, were investigated. During storage, significant interaction effect of 'accession x day of storage' on weight loss, glucose content, PG and PME enzymes activities were observed. Weight loss increased linearly with an average weight loss of 3.9 and 4.9% per day for durian kampung and D24 respectively. The softer texture observed in the Kampung Bentong accession as compared to the D24, corresponded to its higher PG and cellulase activity. Transmission electron microscopy observations showed middle lamella dissolution and loss of intercellular materials in Kampung Bentong accession after 4 days of storage but not in the D24.

The effect of storage temperature on the changes in the physicochemical, microbial and sensory quality of MP durian cultivar D24 was then determined at 28 ± 1 °C for 3 days and 4 ± 2 °C for 35 days. Around 400 g pulp was placed on a polystyrene tray and wrapped with LDPE film for storage. At 28 ± 1 °C, the pulp retained its colour but softened rapidly after 24 h of storage and became acidic (pH 4.71) after 2 days of

storage due to the formation of citric, succinic, acetic and lactic acids. Titratable acidity of the pulp that increased significantly after 2 days of storage was correlated to the decrease in pH. Sucrose decreased concomitantly with an increase in glucose and fructose concentrations during storage. For pulp stored at 4 ± 2 °C, no noticeable changes in pH were observed. After 1 week of storage, there was a progressive increase in glucose, fructose and sucrose concentration with concomitant increase in total soluble solids. The firmness increased significantly at the end of storage. The organic acid content remained constant throughout the storage period with a slight increase in tartaric acid. Titratable acidity of the pulp decreased significantly after one-week storage and remained constant thereafter. The MP durian fruit could be kept at 4 ± 2 °C for 14 days with acceptable microbiological quality and without development of off-odour. At ambient temperature, MP durian could only be stored for 1 day, after which the pulp became acidic.

The volatile flavour compounds and sensory attributes of MP durian cultivar D24 stored at 4 ± 2 °C for 42 days were examined. The volatile compounds were extracted by SPME and analysed by GC-TOFMS. During storage of MP durian at 4 ± 2 °C, diminution of the major ester compounds was observed after 14 days of storage. All ester compounds decreased significantly after 7 days of storage except for ethyl acetate that decreased significantly after 2 weeks of storage. Ethanethiol, 1-propanethiol, and both isomers of 3,5-dimethyl 1,2,4-trithiolane decreased significantly after 7 days of storage. Total sulfur content of the pulp remained unchanged after 42 days of storage. However, sulfur notes perceived by panellists decreased gradually throughout storage. Quantitative

Descriptive Analysis (QDA) was carried out using sixteen descriptors to describe the surface colour, odour, flavour and texture of pulp during storage. Results revealed that pulp could be stored for 21 days, after which off flavour developed and the green aroma became too intense and rendered the pulp unacceptable.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia bagi memenuhi keperluan untuk Ijazah Doctor Filosofi

**CIRI-CIRI FIZIKOKIMIA BUAH DAN ISI SEGAR DURIAN (*Durio zibethinus*)
YANG DISIMPAN PADA SUHU BILIK DAN SEJUKDINGIN**

Oleh

VOON YIT YANG

Disember 2007

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Kajian ini melapor perubahan fiziko-kimia yang berlaku di dalam pulpa buah durian yang belum dikupas dan durian dipotong segar (*Durio zibethinus*) yang disimpan di suhu bilik dan suhu sejukdingin. Di bahagian pertama kajian ini, pH, jumlah pejal larut, keacidan-tertitrat, gula, asid organic, sebatian perisa dan ciri deria lima kultivar durian Malaysia ('D2', 'D24', 'MDUR78', 'D101' dan 'Chuk') telah dikenalpasti. Terdapat perbezaan yang ketara dalam ciri-ciri kimia antara kultivar. Analisis dengan menggunakan pengasingan micro fasa-pepejal (SPME) bersama kromatografi gas-spektrometri jisim masa penerbangan (GC-TOFMS) menyerlah sejumlah 22 ester, 14 sebatian sulfur, 7 alkohol, 3 aldehid, dan 1 keton dalam isi 5 kultivar durian. Ciri deria empat kultivar durian telah dibandingkan. Sebanyak 14 penggambar (bau manis, buah-buahan, sulfur, alcohol, kacang, dan bau hijau, warna permukaan, kemanisan,

kepahitan, kelekatan, kebasahan and lepas-rasa keseluruhan) telah dihasilkan. Ko-relasi yang kuat diperhatikan di antara ciri-ciri deria, sebatian perisa dan ciri-ciri fizikal dan kimia buah.

Dalam bahagian kedua kajian, aktiviti empat enzim hidrolisis dinding sel, pektinmetilesterase (PME), poligalakturonase (PG), cellulase dan β -galaktosidase (β -Gal) serta perubahan fizikokimia buah durian yang ranum dan belum dikupas dari Kultivar D24 dan aksesion Kampung Bentong, Pahang yang dan disimpan pada suhu 28 ± 1 °C (RH 60-80%) selama 4 hari telah disiasat. Sewaktu simpanan, kesan interaksi yang ketara antara kultivar dan hari penyimpanan ke atas kehilangan berat, kandungan glukosa, activity PG dan PME telah diperhatikan. Kehilangan berat meningkat secara linear dengan purata kehilangan berat 3.9% dan 4.9% per hari bagi aksesion Kampung Bentong dan D24 masing-masing. Tekstur yang lebih lembut yang diperhatikan dalam aksesion Kampung Bentong berbanding dengan kultivar D24, bersamaan dengan aktiviti enzim PG dan cellulase yang lebih tinggi di dalamnya. Pemeriksaan dengan mikroskop penembusan elektron menunjukkan pencernaan lamela tengah di antara sel durian dan kehilangan bahan intersel dalam aksesion Kampung Bentong selepas 4 hari penyimpanan tetapi tidak dalam D24.

Kesan suhu simpanan ke atas kualiti fizikal dan kimia, microbiologi dan deria bagi durian kultivar D24 diproses-minima telah dikenalpasti pada 28 °C untuk 3 hari dan pada 4 ± 2 °C untuk 35 hari. Lebih kurang 400 g isi ditaruh di atas bekas polystyrene dan dibalut dengan flim LDPE untuk disimpan. Pada 28 ± 1 °C, isi mengekalkan warnanya

tetapi lembik dengan cepatnya selepas 24 jam simpanan dan menjadi asidik (pH 4.71) selepas 2 hari disimpan disebabkan oleh penghasilan asid sitrik, suksinik, asetik, dan laktik. Keasidan boleh-titrat isi meningkat dengan ketaranya selepas 2 hari disimpan, sekadar dengan penurunan dalam pH. Sukrosa berkurangan sehubungan dengan peningkatan dalam kepekatan glukosa dan fruktosa sewaktu simpanan. Bagi isi yang disimpan pada 4 ± 2 °C, tidak ada pertukaran yang ketara dalam pH yang diperhatikan. Satu minggu selepas disimpan, terdapat peningkatan dalam kepekatan glukosa, fruktosa dan sukrosa secara mendadak sehubungan dengan peningkatan jumlah pepejal boleh larut. Kepejalan meningkat dengan ketaranya semasa tamat simpanan. Kandungan asid organik kekal sepanjang waktu simpan dengan sedikit peningkatan dalam asid tartarik. Keasidan-boleh-dititrat isi berkurangan dengan ketaranyaselepas satu minggu penyimpanan dan kekal sama selepas itu. Buah durian diproses-minima boleh disimpan pada 4 ± 2 °C untuk 14 hari dengan kualiti mikrobiologi yang boleh diterima dan tanpa pembentukan bau busuk. Di bawah suhu bilik, durian diproses-minima boleh disimpan untuk 1 hari sahaja, di mana isi tersebut menjadi asidik selepas itu.

Sebatian bau mudah tersejat dan ciri-ciri deria bagi durian kultivar D24 yang disimpan di bawah 4 ± 2 °C untuk 42 hari diperiksa. Sebatian mudah-sejat diasingkan dengan menggunakan SPME dan dianalisa dengan GC-TOFMS. Sepanjang penyimpanan durian diproses-minima pada 4 ± 2 °C, pengurangan sebatian-sebatian ester yang utama diperhatikan selepas 14 hari penyimpanan. Semua sebatian ester berkurangan dengan ketaranyaselepas 7 hari simpanan kecuali sebatian etil asetat yang hanya berkurangan dengan ketaranya selepas 2 minggu simpanan. Ethanethiol, 1-propanethiol, dan kedua-

dua isomers bagi 3,5-dimethyl 1,2,4-trithiolane berkurangan dengan ketaranya selepas 7 hari penyimpanan. Jumlah kandungan sulfur isi durian kekal tidak berubah selepas 42 hari penyimpanan. Bagaimanapun, rasa sulfur yang dikesan oleh penguji berkurangan perlahan-lahan sepanjang simpanan. Analisis kuantitatif diskriptif (QDA) dilaksanakan dengan menggunakan 16 penggambar untuk menjelaskan warna permukaan, bau, rasa dan tekstur isi semasa simpanan. Keputusan menyiarkan isi durian boleh disimpan untuk 21 hari, selepas itu aroma hijau menjadi terlalu pekat dan menyebabkan isi tidak diterima.

ACKNOWLEDGEMENT

Thanks to Dr. Quek Siew Young, who had started me on this journey although could not accompany me till the end of it. I am indebted to Dr. Nazimah who always have stressed that “If you can get your PhD, you can do anything you want in life” for being supportive all the time and provided me with invaluable advices, on my study as well as being a mankind. Thanks to Prof. Dr. Gulam who makes me believe that I am capable, and giving me confident all the time. Thanks to Dr. Azizah Osman for providing me a place to carry on my lab work and being there to help until the end of my study. I still couldn’t come up with any glowing words to show my appreciation to you all.

To my parents, sisters, brother and relatives, thank you for being patient and understanding. Greatest appreciation is due to my beloved boyfriend, Wei Nam who taught me the way to take things easy and carry out things step by step. Thanks to Osho and Zhuang Zi, although they don’t even know me, for their books have accompanied me throughout my study and remind me of treasuring every moment of life.

I would like to express my appreciation to my lab mates and course mates especially Bee Tein, Tuck Keong, Chun Kiat, Sung Tong, Soek Meng, Horng Eng, Wai Cheng, and Hwee Nee for being so helpful and supportive. Their presence has made the journey of this study an enjoyable one.



My sincerely thanks are also due to my 12 sensory panellists for their present in every sensory sessions. Thanks to all the staffs of the faculty of Food Science and Technology especially Mr. Halim, Mr. Azman and Miss Linawati for providing technical support. I am also grateful to Mr. Ho from IBS, Dr. Shamsul Bahri, Mdm. Chan Jee Leene, Mr. Dorahman Yusof and Mr. Suhaimi from LGM for their assistant in the TEM and light microscopic works.

Last but not the least, I thank God for leading me to this journey and sent all these helpful people to assist me.



I certify that an Examination Committee has met on 18 August 2008 to conduct the final examination of Voon Yit Yang on her thesis entitled “Physicochemical Properties of Durian (*Durio zibethinus*) Stored at Ambient and Refrigerated Temperatures” in accordance with the Universiti and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

VOON YIT YANG

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LIST OF ABBREVIATION

%	percent
°C	degree centigrade
µl	microliter
µm	micrometer
amu	atomic scan unit
ANOVA	analysis of variance
ASP	alkaline-soluble pectin
β -Gal	β -Galactosidase
cfu	colony-forming unit
cm	centimeter
DRBC	Dichloran Rose Bengal Chloramphenicol
DVB/CAR/PDMS	divinylbenzene/ carboxen/polydimethylsilox
eV	electron voltage
g	gravity
GC	Gas Chromatography
GCMS	Gas Chromatography Mass Spectrometry
GC-TOFMS	Gas Chromatography- Time of Flight Mass Spectrometry
HPLC	High Performance Liquid Chromatography
h	hours
HS	head space
i.d.	internal diameter
IS	internal standard



kg	kilogram
L	liter
LSD	Least significant difference
MATRADE	Malaysia External Trade Development Corporation
m	meter
<i>m/z</i>	mass spectra
min	minute
min ⁻¹	per minute
mm	millimeter
MP	minimally processed
N	newton
ND	not detected
nm	nanomole
OSP	Oxalate-soluble pectin
Pa	pascal
PC	principal component
PCA	Plate Count Agar
PDA	Potato Dextrose Agar
PG	Polygalacturonase
PME	Pectinmethylesterase
ppb	parts per billion
ppm	parts per million
QDA	quantitative descriptive analysis