

**CHANGES IN PEEL AND PULP CHARACTERISTICS OF BANANA
(*Musa* AAA 'WILLIAM CAVENDISH') AS INFLUENCED BY RIPENING
TEMPERATURES**

By

SHAHIDA BINTI HASHIM

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

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DEDICATION

This thesis is dedicated to my father who is always giving me his support, mother who is always praying for my well being and my siblings who will always light up my life.

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

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Chairman: Associate Professor Siti Hajar Ahmad, PhD

Faculty: Agriculture

A study on the changes in peel (colour, chlorophyll and carotenoid content, chlorophyll oxidase activity and chlorophyll derivatives) and pulp ripening characteristics (firmness, soluble solids concentration, titratable acidity and pH) of banana (*Musa* AAA 'William Cavendish') were conducted. Five mature green banana fingers per polystyrene tray were induced to ripen using 1000 μ l/L ethylene gas. Five banana fingers per tray were wrapped with a plastic cling-wrap film. The film was then injected with syringe to induced ripening against the fruits using 1000 μ l/L ethylene gas. Masking tape was then used to prevent the gas from moving out from the tray. The tray containing the banana fruits was then kept in a ripening chamber at 18 \pm 2 and 27 \pm 2 $^{\circ}$ C. After 24 hour, the film was removed and the fruit was allowed to continue ripening in respective temperatures until day five of ripening. The experiment was conducted using a randomized complete block design (RCBD) with a factorial arrangement of treatments (2 ripening temperatures x 6 ripening days) with five replications. Data from measurements of the peel (colour, chlorophyll and carotenoid contents, chlorophyll oxidase activity and

chlorophyll derivatives) and pulp ripening characteristics were analyzed using analysis of variance (ANOVA) and regression were done using general linear model (GLM) (SAS Institute, Cary, N.C., 1989). Treatment differences were separated using Duncan multiple range test (DMRT). Correlation analysis by means of Pearson's correlation matrix was performed to establish the associations between each parameter.

The peel colour, chlorophyll and carotenoid content, chlorophyll oxidase activity and chlorophyll derivatives of Cavendish were affected by the interaction between ripening temperature x ripening day. The results of this study showed that the combination of high L^* and C^* with low h^0 value produced light-vivid-yellow colour in peel of Cavendish banana ripened at 18 ± 2 °C (CBR18). However, peel of Cavendish ripened at 27 ± 2 °C (CBR27) produced dark-pale-green colour as indicated by low L^* and C^* combined with high h^0 value. The study showed that about 70% of the total chlorophyll content (total chl) had disappeared when Cavendish banana was ripened at 18 ± 2 °C and the banana peel attained bright yellow colour. However, total chl of CBR27 decreased by 27% as ripening progressed. There was no significant difference in the content of peel α and β -carotene of CBR18 and CBR27 at different days of ripening. A steady increase in the peel lutein was noted at both ripening temperatures. The activity of chlorophyll oxidase (chlox) increased both linearly and quadratically as ripening progressed from ripening day zero to ripening day five in CBR18 peel. However, the peel chlox of CBR27 had a significant linear decrease ($R^2 = 0.96$) as fruit ripened. Chlorophyllide a (chl a) increased as chlorophyll a (chl a) decreased with

degreening of CBR18 peel. Chlide *a* in CBR18 seems to be degraded to pheophorbide *a* (phb *a*) as indicated by increasing in phb *a*, which is subsequently converted to colourless low molecular weight compounds. The results of this study also showed that chl *a-1* increased as Chl *a* decreased. Results also indicated that the peel total chl, chl *a* and chl *b* of CBR18 had a significant positive correlation with h° value. There was significant correlation between peel colour values (L^* , C^* and h°) and peel carotenoid (α -carotene, β -carotene and lutein) in CBR18. The h° value of CBR18 had no significant correlation ($r^2 = 0.05$) with chlorophyll oxidase activity. The results showed that h° value of peel CBR27 had a significant positive correlation with total chl ($r^2 = 0.53$), chl *a* ($r^2 = 0.53$) and chl *b* ($r^2 = 0.73$). The peel h° value of CBR27 also showed significant positive correlation with peel carotenoid (α -carotene, β -carotene and lutein). The ripening characteristics (firmness, soluble solids concentration, titratable acidity and pH) of Cavendish pulp were affected by the interaction between ripening temperature x ripening day (RD). The pulp of CBR27 tended to be softer and sweeter than CBR18 as ripening progressed from RD0 to RD5.

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

**PENGARUH SUHU PEMERAMAN TERHADAP PERUBAHAN KULIT
DAN ISI BUAH PISANG CAVENDISH (*Musa* AAA ‘WILLIAM
CAVENDISH’)**

Oleh

SHAHIDA BINTI HASHIM

September 2006

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Suatu kajian tentang perubahan kulit (warna, kandungan klorofil dan karotenoid, aktiviti klorofil oksida dan terbitan-terbitan klorofil) dan isi (kekerasan, kandungan pepejal terlarut, keasidan tertitrat dan pH) buah pisang (*Musa* AAA ‘William Cavendish’) telah dijalankan. Lima biji pisang yang diletakkan di atas bekas polistirena yang dibalut dengan filem pembalut telah diperam dengan menggunakan 1000 μ l/L gas etilena. Pisang yang sudah siap dibalut diperam di dalam bilik pemeraman pada suhu 18 \pm 2 and 27 \pm 2 °C. Setelah 24 jam, filem pembalut dibuka dan pisang diperam pada suhu tersebut sehingga hari ke lima pemeraman. Ujikaji ini dijalankan dengan menggunakan rekabentuk blok rawak lengkap (RCBD) di mana rawatannya disusun secara faktorial (2 suhu pemeraman x 6 hari pemeraman) dengan mengandungi 5 replikasi. Data yang diperolehi daripada kulit (warna, kandungan klorofil dan karotenoid, aktiviti klorofil oksida dan terbitan-terbitan klorofil) dan isi (kekerasan, kandungan pepejal terlarut, keasidan tertitrat dan pH) dianalisa dengan menggunakan kaedah analisis varian (ANOVA) dan regresi dijalankan dengan menggunakan model linear umum

(GLM) (SAS Institute, Cary, N.C., 1989). Perbezaan antara setiap rawatan ditentukan dengan menggunakan kaedah *Duncan multiple range test* (DMRT). Analisis korelasi menggunakan min *Pearson's correlation matrix* telah digunakan untuk mengetahui hubungan di antara rawatan.

Warna, kandungan klorofil dan karotenoid, aktiviti klorofil oksida dan terbitan-terbitan klorofil pada kulit buah pisang Cavendish dipengaruhi oleh interaksi di antara suhu pemeraman dan hari pemeraman. Keputusan ujikaji ini menunjukkan gabungan nilai L^* dan C^* yang tinggi serta nilai h^0 yang rendah menghasilkan kulit yang berwarna kuning terang pada pisang Cavendish yang diperam pada suhu 18 ± 2 °C (CBR18). Walaubagaimanapun, pisang Cavendish yang diperam pada suhu 27 ± 2 °C (CBR27) menghasilkan kulit yang berwarna hijau pudar seperti yang ditunjukkan oleh nilai L^* dan C^* yang rendah serta h^0 yang tinggi. Kajian juga menunjukkan 70% daripada kandungan jumlah klorofil hilang apabila pisang Cavendish diperam pada suhu 18 ± 2 °C lalu menghasilkan kulit pisang yang berwarna kuning terang. Bagaimanapun, hanya 27% jumlah klorofil hilang apabila buah pisang diperam pada suhu 27 ± 2 °C. Tidak terdapat perbezaan yang bererti di dalam kandungan α dan β -karotin bagi kulit CBR18 dan CBR27 pada setiap hari pemeraman. Kulit pisang Cavendish yang diperam pada kedua-dua suhu yang berlainan menunjukkan peningkatan yang mantap bagi kandungan lutein. Aktiviti klorofil oksida meningkat secara linear dan kuadratik pada kulit CBR18 semasa pemeraman berlaku daripada hari pemeraman sifar hingga hari ke lima pemeraman. Bagaimanapun, aktiviti klorofil oksida menurun secara linear pada kulit CBR27 semasa pemeraman berlaku. Chlorophyllide *a* (chlide *a*) meningkat sejajar dengan penurunan klorofil *a* dan penyahijauan kulit CB18. Chlide *a* pada

kulit CBR18 seolah-olah didegradasikan kepada pheophorbide *a* (phb *a*) seperti ditunjukkan oleh peningkatan phb *a*, yang mana akan ditukarkan kepada sebatian tidak berwarna yang mempunyai berat molekul yang rendah. Keputusan ujikaji ini juga menunjukkan chl *a*-1 meningkat dengan menurunnya klorofil *a*. Keputusan juga menunjukkan jumlah klorofil, klorofil *a* dan klorofil *b* pada kulit CBR18 mempunyai korelasi positif yang amat bererti dengan nilai h° . Nilai warna (L^* , C^* , h°) pada kulit CBR18 berkorelasi secara bererti dengan kandungan karotenoid (α dan β -karotin, lutin). Nilai h° pada kulit CB18 tidak berkorelasi secara signifikan dengan aktiviti klorofil oksida. Keputusan menunjukkan nilai h° pada kulit CBR27 mempunyai korelasi positif yang signifikan dengan jumlah klorofil ($r^2=0.53$), klorofil *a* ($r^2=0.53$) dan klorofil *b* ($r^2=0.73$). Nilai h° pada kulit CBR27 juga mempunyai korelasi positif dengan α -karotin, β -karotin dan lutin. Sifat-sifat pemeraman (kekerasan, kandungan pepejal terlarut, keasidan tertitrat dan pH) pada isi buah pisang Cavendish dipengaruhi oleh interaksi di antara suhu pemeraman dan hari pemeraman. Isi buah CBR27 lebih lembut dan manis daripada isi buah CBR18 semasa pemeraman buah dilakukan pada hari pemeraman sifar sehingga hari ke lima pemeraman.

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I certify that an Examination Committee has met on 7 September 2006 to conduct the final examination of Shahida binti Hashim on her Master of Science thesis entitled “Changes in Peel and Pulp Characteristics of Banana (*Musa* AAA ‘William Cavendish’) as Influenced by Ripening Temperatures” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher 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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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.

SHAHIDA BINTI HASHIM

Date: 21 DECEMBER 2006

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	vi
ACKNOWLEDGEMENTS	ix
APPROVAL	x
DECLARATION	xii
LIST OF TABLES	xiv
LIST OF FIGURES	xv
 CHAPTER	
I INTRODUCTION	17
II LITERATURE REVIEW	21
Banana	21
Pigments in Fruit	24
Banana Ripening	30
Enzymes Involved in Chlorophyll Degradation	40
III CHANGES IN COLOUR AND PIGMENTS OF BANANA PEEL (<i>Musa</i> AAA ‘WILLIAM CAVENDISH’) DURING FRUIT RIPENING	
Introduction	43
Materials and Methods	46
Results and Discussion	54
Conclusion	83
IV CHANGES IN SELECTED RIPENING CHARACTERISTICS OF BANANA PULP (<i>Musa</i> AAA ‘WILLIAM CAVENDISH’) DURING FRUIT RIPENING	
Introduction	84
Materials and Methods	86
Results and Discussion	89
Conclusion	103
V GENERAL DISCUSSION AND CONCLUSIONS	104
REFERENCES	106
BIODATA OF THE AUTHOR	119

LIST OF TABLES

Table		Page
1	Main and interaction effects of ripening temperature (RT) and ripening day (RD) on peel colour values (h° , C^* and L^*) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	55
2	Main and interaction effects of ripening temperature (RT) and ripening day (RD) on peel total chlorophyll content (total chl), chlorophyll <i>a</i> (chl <i>a</i>), chlorophyll <i>b</i> (chl <i>b</i>), chlorophyll <i>a/b</i> ratio (chl <i>a/b</i>) and chlorophyll oxidase activity (chlox) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	60
3	Main and interaction effects of ripening temperature (RT) and ripening day (RD) on α -carotene, β -carotene and lutein of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	68
4	Correlation coefficients (r) between peel colour (L^* , C^* and h°), total chlorophyll content (total chl), chlorophyll <i>a</i> (chl <i>a</i>), chlorophyll <i>b</i> (chl <i>b</i>), chlorophyll <i>a/b</i> (chl <i>a/b</i>), α -carotene, β -carotene, lutein and chlorophyll oxidase activity (chlox) of peel Cavendish ripened at 18 ± 2 (CBR18).	80
5	Correlation coefficients (r) between peel colour (L^* , C^* and h°), total chlorophyll content (total chl), chlorophyll <i>a</i> (chl <i>a</i>), chlorophyll <i>b</i> (chl <i>b</i>), chlorophyll <i>a/b</i> (chl <i>a/b</i>), α -carotene, β -carotene, lutein and chlorophyll oxidase activity (chlox) of peel Cavendish ripened at 27 ± 2 (CBR27).	82
6	Main and interaction effects of ripening temperature (RT) and ripening day (RD) on pulp firmness, soluble solids concentration (SSC), titratable acidity (TA), pH and of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	90
7	Correlation coefficients (r) between pulp firmness (N), soluble solids concentration (SSC), titratable acidity (TA) and pH of Cavendish ripened at 18 ± 2 (CBR18).	102
8	Correlation coefficients (r) between pulp firmness (N), soluble solids concentration (SSC), titratable acidity (TA) and pH of Cavendish ripened at 27 ± 2 (CBR27).	102

LIST OF FIGURES

Figure		Page
1	Relationship between peel h^0 value and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	56
2	Relationship between peel C^* value and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	57
3	Relationship between peel L^* value and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	58
4	Relationship between total chlorophyll (total chl) and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	62
5	Relationship between chlorophyll a (chl a) and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	63
6	Relationship between chlorophyll b (chl b) and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	64
7	Relationship between chlorophyll a/b ratio (chl a/b) and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	65
8	Relationship between lutein and ripening day Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27). The lines indicate significant linear relationship ($P \leq 0.05$) between peel lutein and RD.	69
9	Relationship between chlorophyll oxidase activity (chlox) and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	71
10	Relationship between peel chlorophyllide a (chl a) and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27).	74
11	Relationship between peel pheophorbide a (phb a) and ripening day of Cavendish banana ripened at 18 ± 2 (CBR18)	75

and 27 ± 2 °C (CBR27).

- | | | |
|----|---|-----|
| 12 | Relationship between peel chlorophyll <i>a</i> -1 (chl <i>a</i> -1) and ripening day (RD0 to RD5) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27). | 77 |
| 13 | Relationship between pulp firmness and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27). | 91 |
| 14 | Relationship between pulp soluble solids concentration (SSC) and ripening day (RD0 to RD5) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27) | 94 |
| 15 | Relationship between pulp titratable acidity (TA) and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27). | 97 |
| 16 | Relationship between pulp pH value and ripening day (RD) of Cavendish banana ripened at 18 ± 2 (CBR18) and 27 ± 2 °C (CBR27). | 100 |