
UNIVERSITI PUTRA MALAYSIA

# PHYSICO-CHEMICAL CHANGES IN CAVENDISH BANANA (Musa cavendishii L. var. MONTEL) DURING FRUIT DEVELOPMENT, MATURATION AND STORAGE

RAZALI BIN MUSTAFFA

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**MASTER OF SCIENCE**
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**BY**
**RAZALI BIN MUSTAFFA**

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Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degree of Master of Science.

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RAZALI BIN MUSTAFFA

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Chairman : Azizah Osman, Ph.D.

Faculty : Food Science and Biotechnology

Studies on the physico-chemical changes between different hand positions (top, middle and bottom) within a bunch and different finger positions (upper and lower) within a hand at different maturity stages (between 3 to 15 weeks from the appearance of flower emergence) were carried out on 'Montel' banana (*Musa cavendishii* L). The size, weight, volume and peel colour of fruits increased significantly ($P<0.01$) for fruits from all positions (hands and fingers within a hand) within a bunch until the end of maturity stage. On the other hand, fruit texture decreased significantly ($P<0.01$). The total soluble solids (TSS), ascorbic acid (AA) and sugar contents increased slowly during development, but the increase was rapid during ripening. The starch composition accumulated gradually ($P<0.05$) at the early stages and decreased thereafter. The pH and titratable acidity values showed an

irregular pattern in all the fruits from all positions during the maturity stage. There was a signifcant decrease ($P<0.01$) in the tannin content between the different portions of hands within a bunch and between different fingers within a hand at maturity. There was an increase in AIS at the early stages, but after approaching maturity (week 12), it decreased significantly ($P<0.05$) in the ripe fruits. The pectins increased at the early stages until a maximum at week 12 and then slowly decreased. At the end of maturity stage, the pectic substances started to increase slowly until the ripening stage. The suitable harvesting stage was found to be between 12 to 15 weeks after flower emergence. Postharvest treatment with liquid paraffin, clingwrap, low density polyethylene (LDPE) with and without potassium permanganate ($KMnO_4$) were studied to extend the shelf life of 'Montel' banana (*Musa cavendishii* L.), under refrigeration (15±1°C) and at ambient temperature (27±1°C). The fruits packed in LDPE with $KMnO_4$ ripened within 60 days after harvesting at week 12 from flower emergence. This was followed by fruits packed in LDPE without $KMnO_4$ (54 days), clingwrap (42 days), liquid paraffin (36 days), control at 15°C (24 days) and control at ambient (18 days). The percentage weight loss, peel and pulp colours of fruits increased significantly ($P<0.01$) for all treatments during storage. On the other hand, the texture values and tannin content of the fruit decreased significantly ($P<0.01$) during storage. The rise in total soluble solids (TSS) and sugar were slow initially but gradually increase rapidly at the end of the storage period. However, pH, titratable acidity (TA), ascorbic acid (AA) and starch contents of fruits from all treatments were found to be inconsistent during storage. There is a highly significant difference ($P<0.01$) in the production of $C_2H_4$ and $CO_2$ found from fruits of all treatments during storage. Fruits packed in low density polyethylene (LDPE) with

**$KMnO_4$ was found to be the best treatment to extend the storage life of `Montel' banana.**

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

# PERUBAHAN-PERUBAHAN FIZIKO-KIMIA BUAH PISANG CAVENDISH (*Musa cavendishii* L. var. MONTEL) SEMASA PERKEMBANGAN, KEMATANGAN DAN PENYIMPANAN

oleh

RAZALI BIN MUSTAFFA

Januari, 1997

Pengerusi : Azizah Osman, Ph.D.

Fakulti : Sains Makanan dan Bioteknologi

Kajian ke atas perubahan fiziko-kimia buah pisang `Montel' pada kedudukan sikat yang berbeza (atas, tengah dan bawah) dalam satu tandan dan juga pada kedudukan buah yang berlainan (atas dan bawah) dalam satu sikat pada peringkat kematangan yang berlainan di antara 3 hingga 15 minggu dari bermulanya pengeluaran jantung telah dijalankan. Saiz, berat, isipadu dan warna kulit buah menunjukkan peningkatan yang sangat bererti ($P<0.01$) bagi buah-buah pada setiap kedudukan (sikat dan buah dalam satu sikat) pada tandan yang sama sehingga di akhir peringkat kematangan. Selain daripada itu, tekstur buah menurun dengan sangat bererti ($P<0.01$). Jumlah pepejal larut (JPL), asid askorbik (AA) dan kandungan gula meningkat dengan perlahan semasa perkembangan tetapi kemudian meningkat dengan ketara semasa kemasakan. Komposisi kanji terkumpul secara beransur-ansur

($P<0.05$) pada peringkat awal perkembangan dan akhirnya menurun. Nilai-nilai pH dan asid tertitrat (AT) menunjukkan perubahan yang tidak sekata bagi buah-buah pada setiap kedudukan semasa peringkat kematangan. Terdapat perbezaan penurunan yang sangat bererti ($P<0.01$) bagi kandungan tanin di antara kedudukan sikat yang berbeza dalam satu tandan dan juga kedudukan buah dalam satu sikat semasa kematangan. Terdapat juga peningkatan kandungan AIS pada awal peringkat perkembangan tetapi apabila sampai ke peringkat kematangan (minggu 12), kandungannya menurun dengan bererti ($P<0.05$) pada buah-buah yang masak. Kandungan pektin pula meningkat di awal peringkat perkembangan sehingga mencapai tahap maksimum pada minggu 12 dan akhirnya menurun secara perlahan-lahan. Pada akhir peringkat kematangan, bahan-bahan pektik mulai meningkat secara perlahan sehingga ke peringkat kemasakan. Peringkat penuaian yang sesuai adalah di antara 12 hingga 15 minggu selepas pengeluaran jantung. Rawatan-rawatan lepastuai dengan menggunakan cecair parafin, "clingwrap", polietilena ketumpatan rendah (LDPE) dengan dan tanpa kalium permanganat ($KMnO_4$) telah dikaji untuk memanjangkan hayat simpanan buah pisang `Montel' (*Musa cavendishii* L.) pada suhu penyimpanan (15±1°C) dan suhu ambien (27±1°C). Buah-buah yang dibungkus dalam LDPE dengan $KMnO_4$ telah mencapai peringkat kemasakan dalam jangkamasa 60 hari selepas dituai pada minggu 12 dari pengeluaran jantung. Ini diikuti oleh rawatan-rawatan bagi buah-buah yang dibungkus dalam LDPE tanpa $KMnO_4$ (54 hari), "clingwrap" (42 hari), cecair parafin (36 hari), kawalan pada suhu 15°C (24 hari) dan kawalan pada suhu ambien (18 hari). Peratus kehilangan berat, warna kulit dan isi buah telah meningkat dengan sangat bererti ($P<0.01$) pada semua rawatan semasa penyimpanan. Di samping itu, nilai-nilai tekstur dan kandungan tanin buah

telah menurun dengan sangat bererti ($P<0.01$). Jumlah pepejal larut (JPL) dan kandungan gula telah menurun dengan perlahan-lahan semasa di peringkat awal penyimpanan tetapi kemudian meningkat dengan ketara di akhir tempoh penyimpanan. Nilai pH, asid tertitrat (AT), asid askorbik (AA) dan kandungan kanji menunjukkan perubahan yang tidak seragam dalam buah-buah dari semua rawatan semasa penyimpanan. Pengeluaran etilena ($C_2H_4$) dan karbon dioksida ($CO_2$) menunjukkan perbezaan yang sangat bererti ($P<0.01$) bagi buah-buah dari semua rawatan semasa penyimpanan. Buah-buah yang dibungkus dalam LDPE dengan $KMnO_4$ didapati telah memberi kesan rawatan yang paling baik untuk memanjangkan hayat simpanan buah pisang `Montel'.

# CHAPTER 1

## GENERAL INTRODUCTION

Banana (*Musa cavendishii* L., AAA Group), the Cavendish subgroup (Stover and Simmonds, 1987) was introduced into Malaysia from South America (Simmonds, 1966). Bananas have been associated with man for centuries and many consider the banana to be one of man's finest foods (Cheeseman, 1939; Von Loesecke, 1950). Their origin appears to be Southeast Asia; Eastern Malaysia and the Philippines, in particular, were considered as the primary source (Simmonds, 1962). Although evidence suggests that the banana could have originated in Malaysia, the banana industry never really developed in this country. In 1966, the total area of banana cultivation in West Malaysia was only 6082 hectares (F.A.M.A., 1968). In recent years, banana cultivation in Malaysia is fast becoming a growing industry with the involvement of several private growers and government agencies in the activity. Banana has the potential to continue being a commercial crop based on its major contribution to the agricultural sector. Its industry has already been long established through the involvement of several multinational companies.

In Malaysia, banana planting area was 23,952 ha in 1984 and increased to 35,449 ha in 1992 (F.A.MA., 1994). The export of banana also rose from 32,630 tonnes in 1984 to 37,169 tonnes in 1993. The importer countries are Brunei, Hong Kong, Japan, Singapore, etc. (Jabatan Perangkaan Malaysia, 1993). A new export destination for Malaysian fruits since early 1991 is South Korea. Exports of the Cavendish banana to South Korea in 1991 was RM1,788,037 (13.44%) and RM1,869,449 (14.05%) for Japan. However, small quantities of fruits were also exported to Taiwan (F.A.M.A., 1993). The estimated world production of bananas