QUANTITATIVE ANALYSIS OF MINERALS AND VITAMIN C IN BANANAS (*Musa acuminata*)

TAN YEONG SHENG

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE WITH HONOURS

INDUSTRIAL CHEMISTRY PROGRAMME
SCHOOL OF SCIENCE AND TECHNOLOGY
UNIVERSITY MALAYSIA SABAH

APRIL, 2007

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS@

JUDUL: QUANTITATIVE ANALYSIS OF MINERAL AND VITAMIN C IN BANANAS (Musa acuminata)

Ijazah: Sarjana Muda Kimia Industri

SESI PENGAJIAN: 6

Saya TAN YOONG SHENG

(HURUF BESAR)

mengaku membenarkan tesis (LPS/Sarjana/Doktor Falsafah)* ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (/)

☐	SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	TIDAK TERHAD

(TANDATANGAN PENULIS)

Alamat Tetap: 2-G, Medan Tembaga, 11600 Pulau Pinang

Tarikh: 13/4/07

Disahkan oleh

(TANDATANGAN PUSTAKAWAN)

MR. MOH PAK YAN

Nama Penyelia

Tarikh: 13/4/07

CATATAN: * Potong yang tidak berkenaan.

** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.

@ Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (LPSM).

DECLARATION

I hereby declare that this dissertation is based on my original work, except for the quotations and summaries each of which have been fully acknowledged.

APRIL, 2007

TAN YEONG SHENG
HS2004-2062

VERIFICATION

NAME : TAN YEONG SHENG

TITLE: QUANTITATIVE ANALYSIS OF MINERALS AND VITAMIN C IN BANANAS (*Musa acuminata*)

(MR. MOH PAK YAN)

(DR. MD. LUTFOR RAHMAN)

(DR. SUHAIMI MD. YASIR)

(SUPT. (K) PROF. MADYA DR. SHARIFF A. K OMANG, ADK)

APRIL, 2007

ACKNOWLEDGEMENT

First and foremost, I would like express deep sense of gratitude and acknowledgement for the help, advice and guidance of my project supervisor, Mr. Moh Pak Yan. Mr. Moh Pak Yan has guided me through the whole project and kindly gives us many useful idea and example. Those example and idea lead me to finish the whole project. Besides, Mr. Moh Pak Yan also gives me the correction when I do some mistake in the project. He uses his valuable time to help me to make my project become better.

Second, I want to show my gratitude to my school, School of Science and Technology (SST). It provides me a very good environment study and does my experiment.

Third, I would like to show my appreciation to Prof. Madya Dr. Marcus Japony who gives me his comment and suggestions for improving my project, his innumerable suggestion improve the completeness of this project.

Finally, I also would like to express gratitude to those who had helped me in my project that I did not mention above. Thanks.

ABSTRACT

Two different varieties of banana, *Musa acuminata* Colla (AA Group) 'Sucrier' and *Musa acuminata* Colla (AAA Group) 'Masak hijau' were analyzed for moisture, ash, minerals (Na, K, Ca, Mg, Zn, Fe and P) and vitamin C contents. Methods in *Association of Official Analytical Chemists* (*AOAC*) were used to determine the moisture and ash contents in bananas. Minerals content were determined by using the method in *Approved Method of the American Association of Cereal Chemists* (*AACC*) while method in *Analytical Chemistry of Foods* was used to determine the phosphorous content. Vitamin C content was determined by using method in *Analytical Chemistry, Practice*. Results showed that the moisture, ash, minerals and vitamin C content in the two varieties of bananas were different. Generally, comparison of data shows that *Musa acuminata* Colla (AA Group) 'Sucrier' has relatively higher Mg, Na, K, Zn and P content which were 34.1±0.6 mg/100g, 5.96±0.26 mg/100g, 281±2 mg/100g, 0.216±0.009 mg/100g and 22.2±0.1 mg/100g respectively compared to 28.2±0.7 mg/100g, 4.33±0.31 mg/100g, 256±2 mg/100g, 0.168±0.008 mg/100g and 20.1±0.1 mg/100g respectively in *Musa acuminata* Colla (AAA Group) 'Masak hijau'. On the other hand, *Musa acuminata* Colla (AAA Group) 'Masak hijau' has relatively higher Ca, Fe and vitamin C content which were 29.3±1.0 mg/100g, 256±2 mg/100g and 19.6±0.3 mg/100g respectively compared to 18.5±0.6 mg/100g, 0.240±0.019 mg/100g and 16.7±0.3 mg/100g respectively in *Musa acuminata* Colla (AAA Group) 'Sucrier'.

*ANALISIS KUANTITATIF KANDUNGAN MINERAL DAN VITAMIN C DALAM PISANG (*Musa acuminata*)*

ABSTRAK

Analisis telah dijalankan ke atas dua varieti pisang, iaitu Musa acuminata *Colla (AA Group) 'Sucrier' and* Musa acuminata *Colla (AAA Group) 'Masak hijau' bagi penentuan kandungan air, abu, mineral (Na, K, Ca, Mg, Zn, Fe and P) dan vitamin C. Kaedah dalam* Association of Official Analytical Chemists (AOAC) *digunakan dalam penentuan kandungan air dan abu dalam pisang. Kandungan mineral ditentukan dengan menggunakan keadah dalam* Approved Method of the American Association of Cereal Chemists (AACC) *manakala kaedah dalam* Analytical Chemistry of Foods *digunakan untuk penentuan kandungan fosforus. Kandungan vitamin C pula ditentukan dengan menggunakan kaedah dalam* Analytical Chemistry, Practisce. *Secara keseluruhan,* Musa acuminata *Colla (AA Group) 'Sucrier' menagndungi kandungan Mg, Na, K, Zn dan P yang lebih tinggi berbanding dengan* Musa acuminata *Colla (AAA Group) 'Masak hijau', iaitu 34.1±0.6 mg/100g, 5.96±0.26 mg/100g, 281±2 mg/100g, 0.216±0.009 mg/100g dan 22.2±0.1 mg/100g berbanding dengan 28.2±0.7 mg/100g, 4.33±0.31 mg/100g, 256±2 mg/100g, 0.168±0.008 mg/100g and 20.1±0.1 mg/100g. Sebaliknya,* Musa acuminata *Colla (AAA Group) 'Masak hijau' mempunyai kandungan Ca, Fe dan vitamin C yang lebih tinngi, iaitu 29.3±1.0 mg/100g, 256±2 mg/100g and 19.6±0.3 mg/100g berbanding dengan 18.5±0.6 mg/100g, 0.240±0.019 mg/100g dan 16.7±0.3 mg/100g dalam* Musa acuminata *(AA Group) 'Sucrier'.*

TABLE OF CONTNETS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF SYMBOLS

AOAC	*Association of the Official Analytical Chemist*
AACC	*American Association of Cereal Chemists*
AAS	Atomic Absorption Spectrophotometer
HPLC	High Performance Liquid Chromatography
UV/Vis Spectrometer	Ultraviolet/Visible Spectrometer
A.D.	*Anno Domini*

CHAPTER 1

INTRODUCTION

1.1 Bananas and Its Importance

Banana, a large tropical plant is a nourishing fruit that grows in the tropics and is popular throughout the world. Bananas are native to the tropics of the eastern hemisphere, where it has been cultivated for more than 4,000 years. As early as 956 A.D., the plant was introduced into the Mediterranean countries and it can now be found in most tropical regions (Bahr and Johnston, 1995).

The banana plant is the largest herb plant in the world. It is classified as herbaceous plant because it grows rapidly from its pseudostem. Trunk of the banana tree is a bundle of elongated leaf bases which grow and wrapped together with a single flowering stem, emerging from the top. Its large leaves spread from the upper portion of the plant (Biggs *et al.*, 2003). Generally, banana tree grows from 2.5 to 9 m tall (The World Book Encyclopedia, 1993). The banana fruit is a berry and is protected by a cover known as the peel. Usually, the fruit is green when unripe and yellow when ripe. The banana fruits are easily digested it may reach a length of 20 cm (The Encyclopedia Americana, 1993). Bananas are rich in nutritional values. Besides carbohydrates, bananas are also rich in vitamin C, B_6, B_2, folate, moisture, energy,

carotene, protein, fiber, ash, calcium, phosphorous, sodium, potassium and niacin (Allen, 1981).

Malaysia is rich with various types of bananas, from the 'gigantic' *Musa acuminata* x *balbisiana* Colla (AAB Group) 'Horn' to the little ones such as *Musa acuminata* Colla (AA Group) 'Sucrier'. There as are more than 14 species of bananas that are planted in plantations mainly in Johor, Perak, Kelantan and Selangor. Nonetheless, bananas also grow in the wild (Allen, 1981). The banana fruit is available all year round and it is always available in cheap price. The varieties of banana have different names and appearances. For instance, *Musa acuminata* Colla (AA Group) 'Sucrier' is the short and little banana, *Musa acuminata* x *balbisiana* Colla (AAB Group) 'Silk' and *Musa acuminata* x *balbisiana* Colla (AAB Group) 'Horn' are often made into fried banana and other banana such as *Musa acuminata* Colla (AA Group) 'Jari buaya' and *Musa acuminata* x *balbisiana* Colla (AAB Group) 'Raja' are dining banana. Because of the unique fragrance produced and the size, banana leaves is often used as wrapper to certain local food such as *nasi lemak*, *pulut*, *lemang*, *tapai*, fried *koay teow* and *kuih tepung pelita*. Moreover, in Sarawak and the east coast of peninsular Malaysia, ribs from banana leaves and trunk from banana plants are used to make traditional handicrafts. Realizing the importance of bananas, the Malaysian government has commercialized bananas, which were once left grown in the wild, in large scale. Hence, bananas have now become one of the sources of income in the country (Hutton, 2000; Singh, 1969; Tate, 1999).

1.2 Objectives

Quantitative analysis is carried out to determine two different types of banana, which are *Musa acuminata* Colla (AA Group) 'Sucrier' and *Musa acuminata* Colla (AAA Group) 'Masak hijau'.

The objectives of this research are:

i. To determine the minerals (calcium, magnesium, sodium, potassium, iron, zinc and phosphorous) in *Musa acuminata* Colla (AA Group) 'Sucrier' and *Musa acuminata* Colla (AAA Group) 'Masak hijau'.
ii. To determine the content of vitamin C in *Musa acuminata* Colla (AA Group) 'Sucrier' and *Musa acuminata* Colla (AAA Group) 'Masak hijau'.

1.3 Scopes

The research was carried out to determine and compare the nutrient contents, which were the minerals (Ca, Fe, Mg, Zn, Na, K and P) and vitamin C content of *Musa acuminata* Colla (AA Group) 'Sucrier' and *Musa acuminata* Colla (AAA Group) 'Masak hijau' by using quantitative analysis. Ash and moisture content of the bananas were determined by using method 936.06 and method 940.263 correspondingly in *Association of Official Analytical Chemists* (*AOAC*). Mineral contents in the bananas were analysed by using atomic absorption spectrophotometry in *Approved Method of the American Association of Cereal Chemists* (*AACC*) while phosphorous content was determined by UV-Vis spectrometer in *Analytical Chemistry of Foods*. Back-titration

method in *Analytical Chemistry, Practice* was used to analyze the vitamin C content in the bananas. The data obtained from the experiment was then interpreted by Microsoft Excel and was compared with each other then with data from literature.

CHAPTER 2

LITERATURE REVIEW

2.1 Banana

Musa is one of the three genera in the family Musaceae. It includes bananas and plantains. There are over 50 species of *Musa* with a broad variety of uses. According to Lohmueller (2003), the banana is classified as follows:

Kingdom: Plantae

Division: Magnoliophyta

Class: Liliopsida

Order: Zingiberales

Family: Musaceae

Genus: *Musa*

The name banana is taken from a local name of the plant in Guinea (Africa). Banana is known as kluai in Thai; saging in tagalog; pisang in Malay; vazha in Tamil; maouz in Arabic; kelaa in Hindi; banane in French; banan in Russian and chuoi in Vietnamese (Hutton, 2000). Generally, bananas are originated in the hot tropical regions of South Asia with India as the centre of the origin of bananas (Samson,

1986). Bananas is also grown in many other places of the world namely Bangladesh, the Caribbean Islands, the Canary Islands, Florida, Egypt, Israel, Ghana, Congo, South Africa, Fiji, Hawaii, Taiwan, Sri Lanka and South East Asia. The greatest acreage of bananas is in Africa, where bananas reach their maximum importance as starchy food (Tai, 1997).

Musa acuminata Colla, a wild diploid banana with seeded fruit native to Malesia, is the major parent of most edible bananas. Human selection and vegetative propogation played an important role in the evolution of edible bananas. Triploid forms presumably emerged through chromosome restitution as they are more vigorous than the diploids. From time to time, further out-crossing of these edible diploid and triploid forms of *M. acuminata* have occurred, not only with the parent species, but also hybridization with *Musa balbisiana* Colla, another wild diploid species with seeded fruit which occurs from India to the Philippines and Papua New Guinea. However, this species is absent in central Malesia. Through process similar to those described, hybridization gave rise to diploid, triploid and tetraploid hybrids. From South-East Asia, the cultivation of banana has spread throughout the tropics and into the subtropics of Asia, America, Australia and Africa (Verheij and Coronel, 1991).

Since a continuously high growth rate leads to high yield, banana is at its best in warm and humid tropical climates. Nevertheless, the crop is so attractive that it is grown right up to its ecological limits. Temperature is a major factor as the optimum for growth is about 27°C and the maximum 38°C. None of the important production centres does the temperature drop below 15°C for long since chilling injury occurs below 13°C. In equatorial highlands, the banana disappears at elevations above 1600

m. Most bananas grow best in full sun but excessive exposure to sunlight causes sunburn. A steady moisture supply is required for optimum growth. Therefore, the monthly rainfall should be 200-220 mm and soil moisture should not be depleted below 60-70% of field capacity. The best soil for banana is a deep, friable loam with good drainage and aeration. High fertility is a great advantage and organic matter content must be 3% or more. The plant tolerates pH values of 4.5-7.5 (Soedirjoatmodjo, 1985).

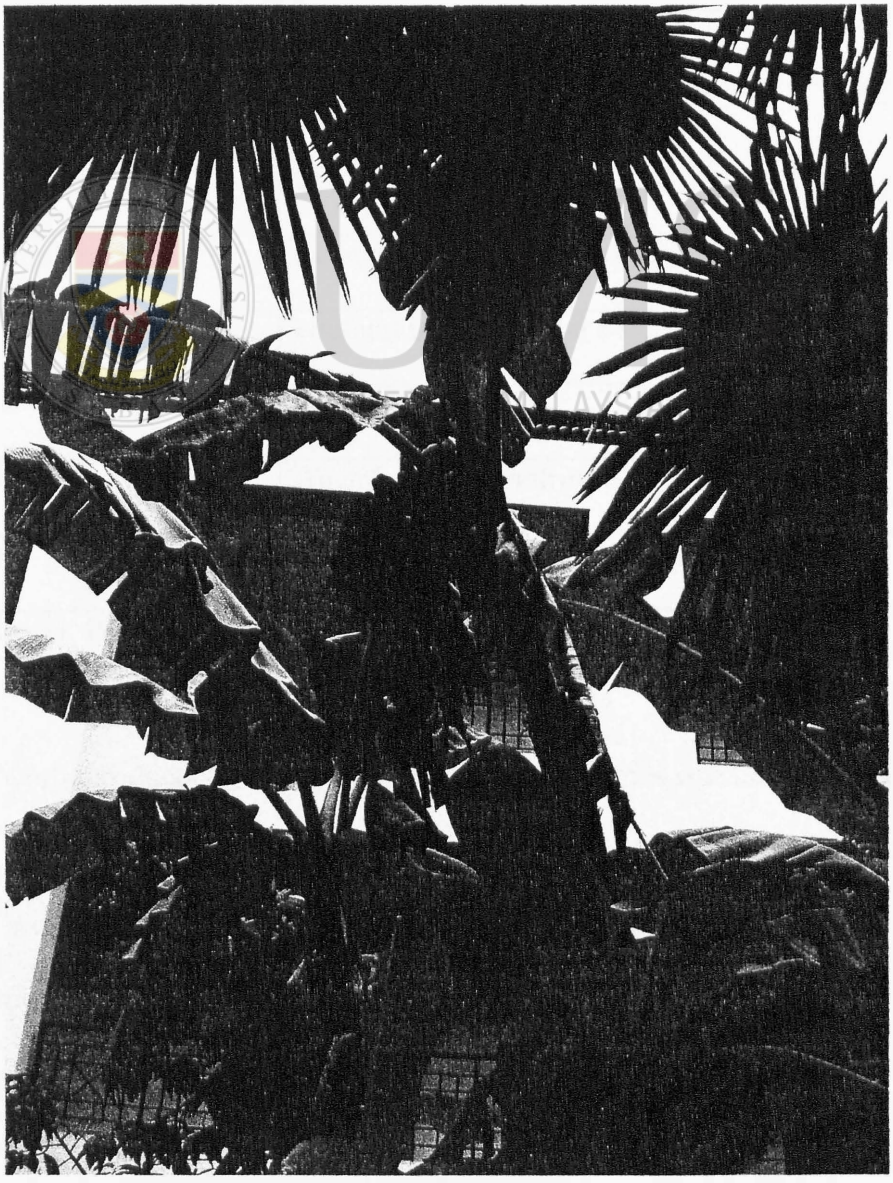

Photo 2.1 Banana plant and fruit.

The fruit of the banana is the main product. It is consumned either raw or cooked. It can be processed into starch, chips, puree, beer and vinegar (Bose, 1985). The other usages of various parts of the banana plant are shown in Table 2.1.

Table 2.1 The uses of the various parts of the banana plant.

Parts of the banana plant	Uses
Male buds	Vegetables
Leaves	Polish floors, line pots and wrappers for foods
Pseudostem	Fibres for making cloth
Vegetative parts and reject fruit	Fodder
Plant	Cultural traditions
Young and unfolded leaves	Relieve chest pains and dressing for blistered skin
Sap	Urethral injections and stimulate hair growth
Juice of root	Febrifuge
Powder	Anemia and malnutrition
Unripe fruit	Diet for diabetics

(Source: Samson, 1986; Hui, 1992)

The world production of bananas in about 120 countries is estimated to be over 68 millions tons annually, more than any other fruit crop. Globally, bananas rank fourth after rice, wheat and maize in human consumption. The banana is the most important fruit species in South-East Asia, ranking first in the Philippines, Indonesia, Thailand and Malaysia. It is also one of the most important export crops in the Philippines and Malaysia (Verheij and Coronel, 1991). Banana growing has been adapted to systems ranging from shifting cultivation to corporate plantations. The

most common form of production in South East Asia is home gardening (Soedirjoatmodjo, 1985).

2.2 Nutrient

A nutrient is a substance needed for the body to develop and function properly. Nutrients that do similar things are grouped together. There six groups of nutrient, namely water, carbohydrates, lipids, proteins, vitamins and minerals. Each nutrient plays a specific role in the body. Together they supply energy, provide materials for growth and maintenance, and control body functions. (Mehas and Rodgers, 2002).

2.2.1 Water

All foods, no matter what the method of processing, contain more or less moisture or water. It comprises from 60 to 95% of all natural foods. Water can be considered the most important dietary constituent. In plant or animal tissues, it may be said to exist in two general forms: "free water" and "bound water" (Matz, 1965).

Free or absorbed water, the most prevalent form, is readily liberated and may be determined by most of the methods used for the determination of moisture. Bound water is combined or adsorbed water. This may present as water from crystallization in hydrates or as water even more firmly bound with protein or saccharide molecules or adsorbed on the surface of colloidal particles. These forms of water require different degrees of heat to remove – some water remaining at temperature up to charring (Hart and Fisher, 1971).