EFFECT OF DIFFERENT COLOURED BAGGING ON POSTHARVEST QUALITY OF SABA BANANA FRUITS

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ABSTRACT

The study was carried out in the banana plot of Faculty of Sustainable Agriculture, Universiti Malaysia Sabah, to evaluate the effect of different coloured bunch bagging on the physico-chemical quality of 'Saba' banana fruits. The bunch covers used were blue, white, black in colours, and no cover as a control arranged in randomised complete block design (RCBD) with three replications. Bunch covers were applied when the banana fingers had started to turn upwards. Fruits were harvested at "full three-quarters" maturity. Parameters measured were colour, finger length and girth, weight loss, pulp to peel ratio, pulp firmness, moisture content, total soluble solids (TSS), pH and titratable acidity (TA). Data were subjected to analysis of variance (ANOVA) using SAS statistical programme. The means were compared using least significant difference (LSD) at significance level of 5%. Results showed that bunch covers did significantly affect finger length, colour, weight loss, pulp moisture content, TSS and pH. However, it did not significantly influence finger girth, pulp to peel ratio, pulp firmness, peel moisture content and TA significantly. Between, 'Saba' banana bagged with black perforated bunch cover showed larger fruit size, brighter peel colour, low weight loss, low TSS content and high acidity level. Moreover, in course of banana fruit ripening, the weight loss, pulp to peel ratio, pulp moisture content, TSS and TA were increased as ripening progressed. In contrast, the pulp firmness, peel moisture content and pH were decreased over the ripening period. Based on the results of the study, it can, thus, be concluded that 'Saba' banana production was not suitable to be bagged with bunch cover due to the local hot and humid climatic condition in a tropical country.

KESAN KEPELBAGAIAN WARNA PEMBUNGKUSAN PADA KUALITI LEPAS TUAI PISANG SABA

ABSTRAK

Kajian ini telah dijalankan di plot pisang Fakulti Pertanian Lestari, Universiti Malaysia Sabah, untuk menilai kesan kepelbagaian warna pembungkusan pada fiziko-kimia kualiti pisang 'Saba'. Pembungkusan yang digunakan adalah dalam warna biru, putih, hitam dan tiada pembungkusan sebagai kawalan yang disusun dalam rawak reka bentuk block lengkap dengan tiga ulangan. Pembungkusan diletakkan apabila jari pisang telah mula menunjuk ke atas. Buah dituai pada "tiga-suku penuh" matang. Parameter yang diukur adalah warna, panjang jari dan ukur lilit, penurunan berat badan, nisbah isi ke kulit, ketegasan pulpa, kandungan kelembapan, jumlah pepejal larut (TSS), pH dan keasidan (TA). Data tertakluk kepada analisis varians (ANOVA) menggunakan program statistik SAS. Min dibandingkan dengan menggunakan *least significant difference* (LSD) pada aras keertian 5%. Hasil kajian menunjukkan bahawa pembungkusan mempengaruhi panjang jari, warna, penurunan berat badan, kandungan kelembapan pulpa, jumlah pepejal larut (TSS) dan pH. Walaubagaimanapun, pembungkusan tidak mempengaruhi lilitan jari, nisbah isi ke kulit, ketegasan pulpa, kandungan kelembapan kulit dan TA dengan ketara. Antaranya, pisang 'Saba' yang dibalut dengan pembungkusan hitam berlubang menunjukkan saiz yang besar, warna kulit cerah, penurunan berat badan yang rendah, kandungan TSS yang rendah dan tahap keasidan yang tinggi. Selain itu, pada masa buah pisang masak, kehilangan berat badan, nisbah isi ke kulit, kandungan kelembapan pulpa, TSS dan TA telah meningkat selama buah kematangan berlangsung. Sebaliknya, ketegasan pulpa, kandungan kelembapan kulit dan pH telah menurun dalam tempoh masak itu. Berdasarkan hasil kajian, kajian ini boleh disimpulkan bahawa pengeluaran pisang 'Saba' tidak sesuai untuk dibalut dengan pembungkusan kerana keadaan iklim yang panas dan lembap di negara tropika.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

±	Plus Minus
°B	Degree Brix
cv.	Cultivated Variety
L*	Lightness
C*	Chroma
h°	Hue Angle
mg	milligram
N	Newton
nm	nanometre
µm	micrometre
ANOVA	Analysis of Variance
FSA	Faculty of Sustainable Agriculture
LSD	Least Significant Differences
RCBD	Randomised Complete Block Design
SAS	Statistical Analysis System
TA	Titratable Acidity
TSS	Total Soluble Solids

LIST OF FORMULAE

CHAPTER 1

INTRODUCTION

1.1 Introduction

Banana is a large perennial herbal plant from a genus *Musa* with extraordinary significance to human societies. They are the fourth most important food crop in the world after rice, wheat and maize (Nelson *et al.*, 2006) and the second most important fruit crop after durian in Malaysia (Nik Hassan, 2003). Banana are grown in more than 150 countries in the world with the world acreage of 5,007,520 hectares, while the world production was 1,036,323,349 metric tonnes and productivity was 20.7 metric tonnes per hectare during the year of 2012 to 2013 (DAC, 2015).

In Malaysia, banana (*Musa* spp.) ranked second in terms of production area covered up to 29,790 hectares with annual production of 294,530 metric tonnes valued at about US$24 million in the year of 2010. There is 15% of the banana produced in a year are exported to Singapore, Brunei, Hong Kong and Middle East valued at more than US$10 million with large proportion of the produces were consumed locally (MARDI, 2011).

'Saba' banana (*Musa balbisiana* cv. Nipah) is the popular banana used in cookery especially in Philippines with its fruit cooked into popular snack foods and the male bud eaten as a vegetable in Filipino dishes. 'Saba' is the common name of this variety in Philippines, synonymous with 'Pisang Nipah' in Malaysia, 'Pisang Kepok' in Indonesia and

'Kluai Hin' in Thailand. 'Saba' banana is a perennial fruit crop under the family of Musaceae with the plant height reach to 4.5 to 5.0 meter at its maximum growth stage (Valmayor *et al.*, 2002).

'Saba' banana is the most important banana cultivar in Philippines with the highest nutritional content among other cultivars due to its deeper root system which allow them to absorb more nutrient from the soil (Health Tips and Natural Healing Benefits, 2012). It is proofed by their long and big girth pseudostem as well as the fruit finger dimension range from 10 to 15 cm in length and 3 to 5 cm in width (Fatimah Corazon *et al.*, 2011). The health benefits of 'Saba' banana include the regulation of circulatory system, source of natural energy, stop constipation, reduce hangover, help to quit smoking and minimize menstrual pains and prevent and treat ulcers (Health Tips and Natural Healing Benefits, 2012).

In under-developed and developing tropical countries, postharvest losses of agricultural products has occurred both quantitatively and qualitatively at all stages from harvesting, through handling, storage, processing, packaging, transportation and marketing until crops are delivered to the final consumers (Olayemi *et al.*, 2012). In such case, the growers are often forced to dispose off their produce over a short period of time (Haidar and Demisse, 1999; Tigist *et al.*, 2011) due to the rain-fed farming system, lack of storage facilities, and limited access to transportation have resulted an economic loss of fruits. Hence, an emphasis to postharvest handling of the fruit is important in order to eliminate any postharvest losses of agricultural products as well as to boost food security and food availability in these countries (Mrema and Rolle, 2002).

Fruit bagging during the production stage in field is the key practice to reduce postharvest losses of banana fruits after harvest. Banana bunch covers ranges from varieties of materials such as polyethylene bag, jute cloth, newspaper, paper bag and available in different thickness and colour in either single or combined-coloured form. Banana bagging is done basically to protect banana fruits from physical injury, sun-burn, leaf scratch, dust and insects during fruit growth and development (Elkashif *et al.*, 2010). Besides of the physical appearance, bunch bagging is also aimed to enhance fruit size,

quality and yield of banana with maximum development of physical and chemical characteristics under cover protection such as fruit weight and sugar content.

Throughout the world, there is increasing concern in the important role played by pre-harvest production practices in the prevention of fruit losses from postharvest chain. Technology such as bunch covering that enhance banana production has not been extensively practiced in Malaysia. Therefore, this study was aimed at the investigation of the effectiveness of different pre bagging materials in enhancing pre- and post-harvest quality of 'Saba' banana.

1.2 Justification

The present study was conducted to evaluate the physical and chemical qualities of 'Saba' banana (*Musa balbisiana* cv. Nipah) during growth and development in the field and also in the postharvest stage at each maturity index throughout the ripening period. 'Saba' banana was chosen for the current study due to its high nutritive value at which it is a rich source of carbohydrate, vitamin B particularly vitamin B6, minerals, potassium and fiber (Robinson and Sauco, 2011). In fact, it is the popular variety in Malaysia favoured by local residents to use in preparing fritters or locally known as 'Pisang Goreng' as the popular snake food in daily life hence it is easily available for this study.

'Saba' banana has long been present in Malaysia, but it had not been planted as the major cultivated varieties in local banana plantations. In fact, 'Saba' banana is claimed to have high resistance to banana bunchy top virus (BBTV) and black sigatoka diseases (dela Cruz *et al.*, 2008). It deserves more attention from the agriculturists. Besides that, there are limited information regarding postharvest quality of 'Saba' banana as influenced by bunch bagging practice have been published as majority of the studies had done their research on dessert banana especially 'Cavendish'.

Therefore, this research was carried out to evaluate the physical and chemical qualities of 'Saba' banana bagged with different coloured of perforated bunch covers at

each maturity index of fruit. Through this research, the information related to the postharvest quality of 'Saba' banana can be greatly increased. We would able to know the benefits of postharvest technology on the quality and quantity of banana fruit and hence it can be exported to global market followed by the possible increasing market demand in the future.

1.3 Research Objective

The objective of this research study was to evaluate the effect of different coloured polyethylene bags on the physico-chemical quality of 'Saba' banana (*Musa balbisiana* cv. Nipah).

1.4 Hypotheses

$H0_1$: Bagging of banana fruit bunches have no effects on the preharvest and postharvest quality of 'Saba' banana.

HA_1: Bagging of banana fruit bunches have effects on the preharvest and postharvest quality of 'Saba' banana.

$H0_2$: Different coloured bags have no effects on the preharvest and postharvest quality of 'Saba' banana.

HA_2: Different coloured bags have effects on the preharvest and postharvest quality of 'Saba' banana.

CHAPTER 2

LITERATURE REVIEW

2.1 Banana (*Musa* spp.)

2.1.1 Taxonomic Classification

Bananas with all its species, varieties or hybrids belong to the family Musaceae which comprised of three genera groups, namely *Musa*, *Ensete* and *Musella*. *Musa* is the most diversified, most ancient and widely distributed group of genus (Karamura, 1998) encompassed a wide diversity of wild and cultivated varieties. Modern edible bananas that grow abundantly nowadays originally came from two wild seeded species, which are *Musa acuminata* Colla (A genome) and *Musa balbisiana* Colla (B genome) (Robinson and Sauco, 2011).

From the natural hybridisation occurred between these two diploid species, various genomic groups have been produced and they were classified according to the method described by Simmonds and Shepherd (1955). It is first, based on the relative contribution of genes A and B from both parents to the constitution of cultivar, and second, to the ploidy or chromosome number of the cultivar. For examples, the clones produced could be pure *acuminata* or *balbisiana* in diploid or triploid derivatives such as AA/BB and AAA/BBB, or hybrids of the two wild species in diploid (AB), triploid (AAB/ABB) or tetraploid (ABBB) (Abdullah Hassan and Pantastico, 1990).

2.1.2 Botanical Description of a Banana Plant

Banana (*Musa* spp.) is a monocotyledonous, giant herbaceous and evergreen perennial plant with complete morphological characteristics. It consists of a compressed, modified stem technically known as a rhizome that bears developing suckers. Besides that, banana plant possess an adventitious root system, a pseudostem (false stem), a crown of large pinnate-veined leaves and an inflorescence that bear flowers which later develops into fruit that we commonly known as banana. In fact, *Musa* species do contained seeds which appear as tiny black specks in the middle of fruit finger (Goncalves and Kernaghan, 2014). However, these seeds are considerably not viable in nature, which in turn contributed to the wide adoptive multiplication of banana through vegetative processes.

The natural growth cycle of banana plant starts from the sucker (shoot) that appears at the ground level alongside with the mother plant. The sucker is growing up simultaneously with mother plant, producing more new leaves, flowering, and ultimately developing a banana bunch. After the bunch is harvested, the aerial portions of plant particularly the banana leaves dry up and die down to the ground. The sucker ("the daughter") which already existed next to the mother plant, replacing the dead tree, and thus maintaining the process on a continuous basis. The whole cycle, from the appearance of the sucker at the ground level until the harvesting of the bunch takes approximately one year of time depending on the variety and the growing conditions.

When the banana tree entered into reproductive phase, a large bullet-shaped inflorescence started to emerge from the centre of the crown of leaves. The immature inflorescence is encased inside purple bracts with 5 to 15 double whorls of floral parts attached on each node of the stout peduncle and arranged in a spiral manner. The inflorescence is classed as a compound spike with the female flowers occurred at the proximal end (closet to the base of the peduncle), male flowers at the distal end (closet to the tip of the peduncle), and sometimes with neuter or hermaphrodite flowers present in between them (Purseglove, 1972).

As the bunch develops, the bracts open in sequence from base to tip, fall off and revealing the developing fruit. The female flowers are developed into edible fruit at which the doubled-rows fruits are called hands while the individual fruit itself called a finger. The entire collection of fruit hands is known as a bunch. In the meantime, the male flowers below the developing fruit shed, leaving a callus scar on the peduncle except for the tip of the stalk, which consists of a 'male bud' that often referred to as the "bell" containing the last-formed male bracts and flowers. It usually will be cut off and removed from the developing bunch to yield better fruit quality and quantity.

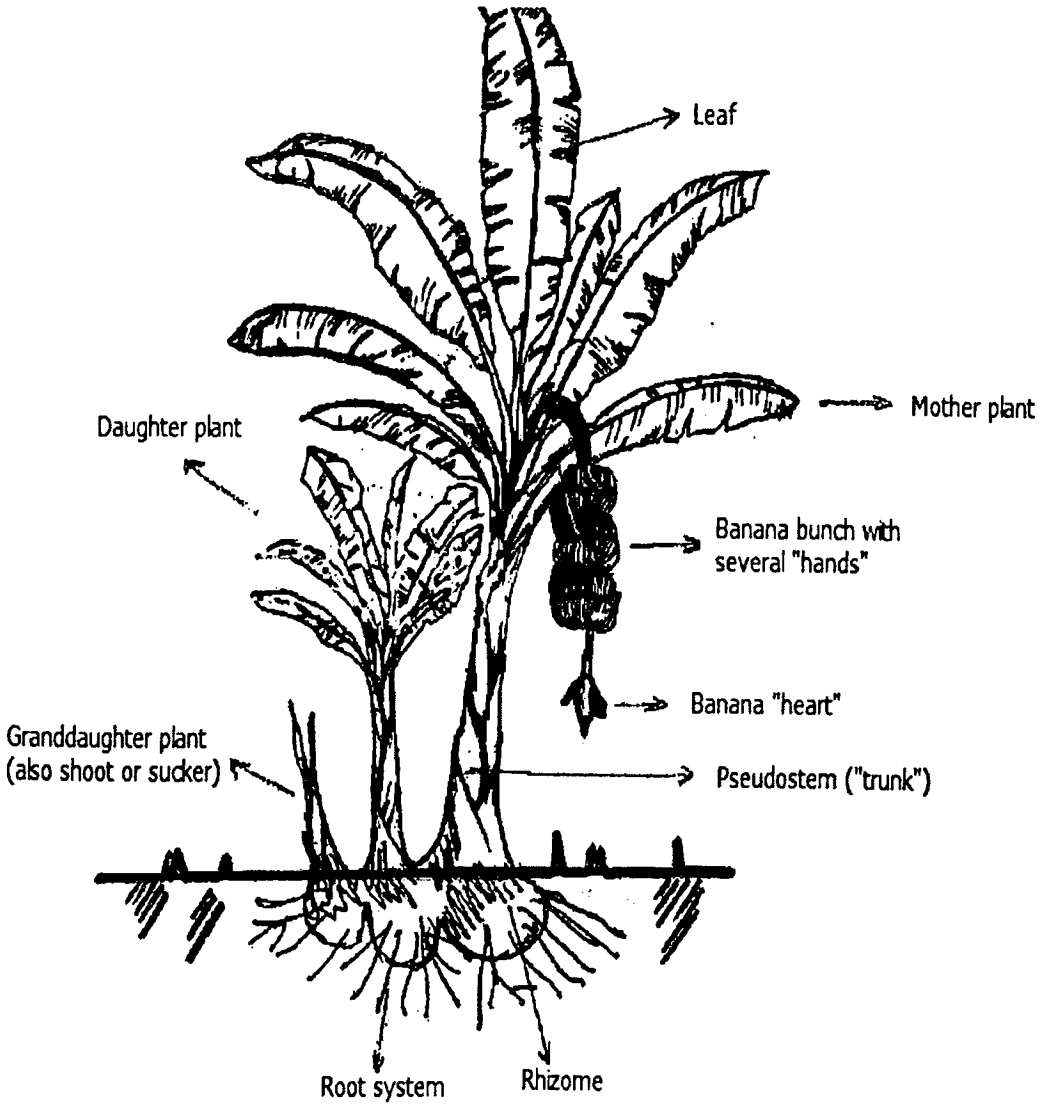


Figure 2.1 Morphological characteristics of a banana plant
Source: EPAGRI, 2002

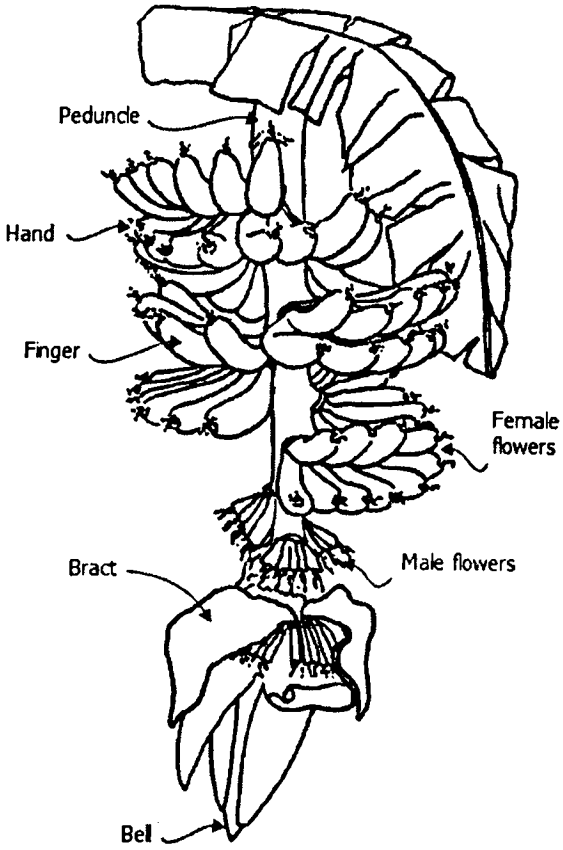


Figure 2.2 A developing bunch of typical banana
Source: Broadley *et al.*, 2004

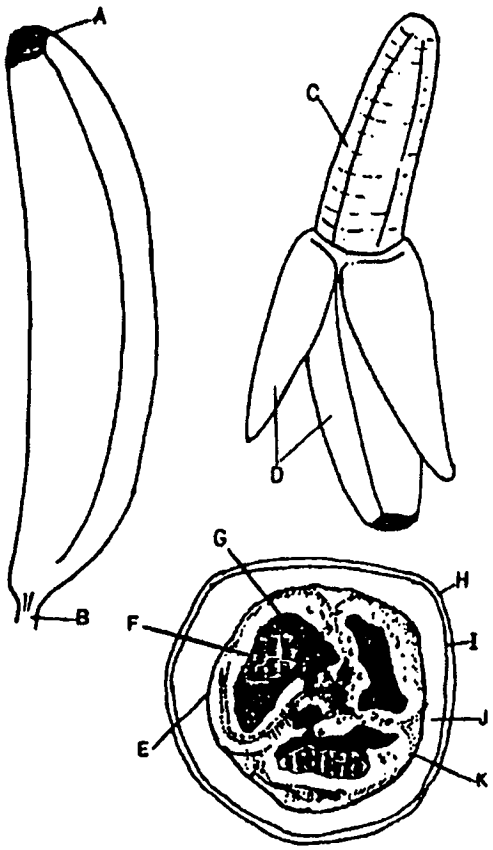
2.1.3 Fruit Structure and Morphology

The banana fruit, despite originating from an inferior ovary of the female flower, can be botanically characterised as a type of berry with a rind that can be easily peeled off from the fleshy pulp. The rind is an outer protective layer of each fruit finger, commonly known as the "skin" or "peel", is a fusion of the floral receptacle and the exocarp of the pericarp. The exocarp is referring to the epidermis which consists of a single layer of cells with stomata and a well-defined cuticle on the outer surface. Below the epidermis, there are 6 to 11 photosynthetic layers (Israeli and Lahav, 1986) that contain chloroplasts which gives the peel green in colour.

The innermost layer of the pericarp, the intertissue strands, contain the pulp-initiating cells that gives way when the ripe banana is peeled. The mesocarp forms the

pulp while the endocarp is limited to the inner epithelium adjacent to the ovarian cavity. In case of edible bananas, they are vegetatively parthenocarpic in that they develop a mass of edible sweetish pulp without pollination unlike the wild seeded bananas which form a dense of hard black seeds resulted from fertilisation (non-parthenocarpic).

The ovules in edible bananas are thus shrivel earlier but may recognisable in mature fruit as minute brown or black patches embedded in the middle of edible pulp. In addition, a characteristic calloused scar at the tip of the fruit is resulted from the abscission of tepals, style and staminodes during the development of fruit from the ovary (OGTR, 2008). Meanwhile, the corresponding end of fruit finger carrying a short pedicel which serves as an attachment point to the crown of the fruit hand.



A- calloused scar
B- attachment
C- pulp
D- peel
E- pericarp
F- mesocarp (pulp)
G- endocarp
H- epidermis
I - photosynthetic layer
J - receptacle
K- intertissue strands

Figure 2.3 Diagrammatic representation of the banana in finger
Source: Abdullah Hassan and Pantastico, 1990

2.1.4 Nutritional Value and Uses

Banana, cooking banana and plantain (*Musa* spp.) are energy-rich fruits with high nutritional value than other common tropical and subtropical fruits such as mango, papaya and orange (Samson, 1980; Morton, 1987). Bananas have become popular in modern westernised diets for their flavour, texture and convenience value, being easy to peel and eat. It is a good source of vitamin A, C and B particularly vitamin B6 (Robinson and Sauco, 2011) which make a significant contribution to the daily dietary requirement of an adult. Besides that, bananas are high in fibre and rich in potassium (K) at which an average-sized banana had 450 to 467 mg of potassium (Lee, 2008).

Dessert banana is commonly used as supplementary snack food as it can be consumed fresh after peeling but plantain and cooking banana are often eaten unripe which used to serve in major part of meal or even in a whole meal. Dessert banana is a good source of energy as it contains high carbohydrate in the fruit pulp. The therapeutic values of dessert banana have been recognised in many special diets such as controlling high blood pressure and heart diseases as it is low in sodium and free from cholesterol.

In addition, the low lipid and high palatability properties of banana makes it become the ideal diet for obese and elderly people. The ripe mashed banana is always the recommended first solid food for babies (Ogazi, 1996) due to easy digestibility and the excellent mineral and vitamin content. It is also eaten by athlete during sport competition as an immediate source of energy.

Meanwhile, plantain has a lower sugar content but high nutritive value especially provitamin A carotenoids which are important in enhancing nutritional status while preventing cancer and other human diseases (Ngoh Newilah *et al.*, 2009). Both the plantain fruits and green bananas rejected from fresh fruit market have been commercially processed into a wide variety of storable products. For examples, roasted plantain and sweets are derived from unripe plantains while banana flour and chips are prepared from green bananas (Poiani *et al.*, 2008). These processed food products can be stored for years as emergency foods in case of food scarcity and famine (Ogazi, 1996).

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