EFFECT OF STORAGE TEMPERATURE AND DURATION ON PHYSICO-CHEMICAL PROPERTIES, MICROBIAL GROWTH AND NUTRITIONAL COMPOSITION OF PAPAYA AND BANANA FRUITS

SUAAD GHAIT ABDARRAHMAN ABUHAMRA

A thesis submitted in
fulfilment of the requirement for the award of the
Master of Science

Faculty of Science Technology and Human Development
Universiti Tun Hussein Onn Malaysia

AUGUST 2017

In the name of Allah, Most Gracious, Most Merciful
All praise and thanks are due to Allah Almighty and peace and
blessings be upon His Messenger

The results of this effort are truly dedicated to my mother and father whose example as devoted professionals, as well as, parents taught me to be perseverant, responsible and loyal to my belief.

To my brothers, and sisters, and my best friend for all their support, encouragement, sacrifice, and especially for their love.

Thank you all and this work is for YOU.

ACKNOWLEDGEMENT

First and foremost I would like express my thanks to Almighty ALLAH on successful completion of this research work and thesis.

I hereby, express my sincere and profound gratitude to my supervisor **Associate Prof. Dr. ALONA CUEVAS LINATOC** and **DATIN RUGAYAH BINTI ISSA** for their continuing assistance, support, guidance, and understanding throughout my graduate studies. Their trust, patience, knowledge, great insight, modesty, and friendly personality have always been an inspiration for me and will deeply influence my career and future life.

The author is grateful to the Faculty of Science, Technology and Human Development, UTHM for the support and facilities provided to carry out the experimental work. The author is also grateful to the staff of the food laboratories for their support, assistance and friendly treatment that not only facilitated the work, but also made it pleasant.

Thanks to all of my colleagues and friends with whom I had the opportunity to learn, share and enjoy. It has been a pleasure. Finally, special and infinite thanks to the most important people in my life, my parents and my husband, for their love, prayers, sacrifice and support.

ABSTRACT

Banana (*Musa sp.*) and papaya (*Carica papaya*) cultivars were harvested and stored for a month at different storage temperatures and durations. These fruits were collected from an orchard which located in Johor Bahru, Malaysia. Ripening in undesired period, change skin color, weight loss, fruits quality loss such as nutrition, high microorganisms infestation rate and fruit damage due to improper storage. The fruits were stored at different durations (0, 3, 6, 14, 30 days) and at varying storage temperatures (4 ±1, 10±2, 30±3 ºC). The color changing, weight loss, total polysaccharide and protein, total soluble sugar (TSS), titratable acidity (TA), pH, free phenolic content (FPC) and microbial growth were determined. The results revealed that parameters were significantly affected by temperature and time. For instance, banana polysaccharide was 20 at 4 ºC, 20 at 10 ºC and 16 mg/L at 30 ºC , banana protein was 1155 at 4 ºC, 1315 at 10 ºC and 1640 at 30 ºC, total soluble sugar was 6.8 at 4 ºC, 7.9 at 10 ºC and 8.2 at 30 ºC, banana pH was 4.8 at 4 ºC, 4.8 at 10 ºC and 5.9 at 30 ºC, papaya free phenolic content (FPC) was 184 at 4 ºC, 245 and 569 mg/L at 30 ºC, and papaya weight loss was 7 at 4 ºC, 15 at 10 ºC and 65% at 30 ºC. However, it was not changed at cold storages prolonged storage period. In addition, the banana peel color was affected by browning and chilling injury into cold storages. Moreover, during storage, total soluble sugar (TSS), total polysaccharide, titratable acidity (TA) and free phenolic content (FPC) increased during cold storage. However, pH, microbial growth, weight and protein estimation whereas decreased during cold storage. In conclusion, according to the obtained results, the optimum storage temperature and duration for banana were found to be 4 °C and 14 days and one month for papaya fruit. The overall findings of this research might be able to provide science-based management tools for the storage performance of banana and papaya fruits.

ABSTRAK

Kultivar pisang (*Musa sp.*) dan betik (*Carica papaya*) dituai dan disimpan selama sebulan pada suhu penyimpanan dan jangka masa berbeza. Buah-buahan ini diambil daripada kebun yang terletak di Johor Bahru, Malaysia. Masak dalam tempoh yang tidak diingini, perubahan warna kulit, penurunan berat, buah-buahan kehilangan kualiti seperti nutrisi, kadar serangan mikroorganisma tinggi, dan kerosakan buah-buahan kerana cara penyimpanan tidak wajar. Buah-buahan itu disimpan pada jangka masa berbeza (0, 3, 6, 14, 30, hari) dan pelbagai suhu penyimpanan (4 ±1, 10±2, 30±3 °C). Perubahan warna, kehilangan berat, jumlah polisakarida dan protein, jumlah gula larut (TSS), keasidan boleh titrat (TA), pH, kandungan bebas fenol (FPC) dan pertumbuhan mikrob ditentukan. Keputusan menunjukkan parameter tersebut dipengaruhi dengan ketara oleh suhu dan masa. Contohnya, polisakarida pisang adalah 20 mg/L pada 4°C, 20 mg/L pada 10°C, dan 16 mg/L pada 30°C, protein pisang adalah 1155 pada 4°C, 1315 pada 10°C, dan 1640 pada 30°C, jumlah gula larut adalah 6.8 pada 4°C, 7.9 pada 10°C, dan 8.2 pada 30°C, pH pisang adalah 4.8 pada 4°C, 4.8 pada 10°C, dan 5.9 pada 30°C, kandungan bebas fenol betik (FPC) adalah 184 pada 4°C, 245 pada 10°C dan 569 mg/L pada 30°C, dan kehilangan berat betik adalah 7 pada 4°C, 15 pada 10°C dan 65% pada 30°C. Warna betik tidak berubah pada jangka masa penyimpanan yang panjang penyimpanan sejuk. Di samping itu, warna kulit pisang terjejas akibat pemerangan dan kecederaan pendinginan ke dalam penyimpanan sejuk. Selain itu, semasa penyimpanan, jumlah gula larut, (TSS), jumlah polisakarida, keasidan boleh titrat (TA), dan kandungan bebas fenol (FPC) meningkat semasa penyimpanan sejuk. Tambahan lagi, pH, pertumbuhan mikrob, berat, dan anggaran protein pula meningkat semasa penyimpanan sejuk. Kesimpulannya, berdasarkan keputusan yang diperoleh, suhu dan jangka masa penyimpanan optimum untuk pisang didapati pada 4°C dan 14 hari dan sebulan untuk buah betik. Dapatan keseluruhan kajian ini boleh menyediakan alat pengurusan berasaskan sains untuk prestasi penyimpanan buah pisang dan betik.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Research Background

1.1.1 Papaya

Papaya (*Carica papaya* L.) belongs to Caricaceae family (Williams, 2005). It is common in central and northern South America (Whipkey *et al.*, 1999; Williams, 2005). There are about sixty countries produce papaya. The total world production of papaya in 2013 (Fact fish, 2015) has been evaluated at 12.419 million tons and 11.22 million tons in 2010. The leading papaya producing region is considered Asia. Therefore, the world production has been assessed between 2008 and 2010. So, the Asia, South America, Africa, Central America, Caribbean, North America and Oceania produced about 52.55%, 23.09%,13.16%, 9.56%, 1.38%, 0.14%, 0.13% of the global production respectively (Evans and Ballen, 2012). The fruit may be ripe when it becomes soft and its skin attains amber to orange hue. Scientific evidence has mentioned that papaya improves human health as a result of bioactive compounds such as phenolic compounds that have potent pharmacological activities, including, anti-mutagenic, antioxidant, anti-inflammatory, anti-hypertension activities anti-fungi and anti-virus (da Silva *et al.*, 2007; Nishijima *et al.*, 1987;

Parris, 1938; Evans and Ballen, 2012). Consequently, the consumption of papaya is increased.

The consumption of papaya fruit in the market are largely restricted to the its quality. The lack of appropriate postharvest technology such as storage conditions may effect on fruits demand. Postharvest handling practices which include packaging and postharvest conditions such as temperature control may be used to keep the fruit quality to prolong storage periods (Rivera-Lopez *et al.*, 2005). Storage temperature is one of the very important environmental factors that affect postharvest life of fresh fruit. The temperature regulates the rate of all associated physiological processes, microbial growth and biochemical reactions (Li and Kader, 1989). Many reports have shown that physico-chemical, physiological, phytochemical, mechanical, sensory qualities and microbial properties of papaya fruits are influenced by packaging, storage temperature, and atmospheric conditions (Williams, 2005). The papaya is very popular worldwide. Furthermore, it is mainly cultivated in tropical countries. Therefore, many non-tropical countries import papaya from Malaysia and other tropical countries. The fruit may be stored at temperatures below 10 °C to extend the marketing value (Azarkan *et al.*, 2003).

The metabolism of mineral nutrients in the plants is influenced by temperature. For instance, the increasing of the transpiration rates in the plants is due to increasing of the environment temperature. The low temperature that less than 10 °C may decreases fruit development, sweetness, and size of papaya. It also influences flower and fruit setting. For instance, stamen carpellody occurs at low temperatures. Therefore, the fruits that develop under the carpellody are severely misshapen and unmarketable (Gonzalez-Aguilar *et al.*, 2003). At higher temperatures that more than 35 °C, there is a tendency of bisexual cultivars to form functional male flowers with poorly developed and non-functional female parts. This tendency may vary with cultivars. Previous study indicated that fluctuating temperatures may cause to reject the amount papaya. In addition, high and low temperature is often encountered for few hours during fruits handling operations (Nunes *et al.*, 2006).

1.1.2 Banana

Banana fruits are produced in tropical and subtropical areas in large quantities. Banana is globally important as a food crop because it is the staple food for millions of people worldwide (Sagi *et al*., 1995). The previous study reported that world production of *Musa* in 2003 was estimated at 102 million tons of which about 68% was classified as bananas and 32% as plantains (Fao and Foods, 2004). The crop of banana is very important for the human being in the growing areas that it forms a major portion of the annual income and a source of food. Production, as well as exports and imports of bananas are highly concentrated in a many countries. Ecuador, India, Brazil and China are considered the major banana-producing countries of total global production which reached about 75% in 2003. Furthermore, Latin America and the Caribbean islands are the major suppliers of banana. Malaysia, Costa Rica, Ecuador, the Philippines and Colombia are exporters countries of banana (Fao and Foods, 2004). There are four common banana cultivars widely grown in all regions in Malaysia. These cultivars are Mas (AA), Embun (AAA), Rastali (AAB) and Berangan (AAA) (Abdullah, *et al.*, 1990). The bananas are exported to Singapore and Brunei Darussalam by loading onto open conventional trucks at ambient temperature (Ratule *et al.*, 2006).

Banana is one of the sixteen fruit types that have been identified by the Malaysian Ministry of Agriculture as having commercial potential either as fresh or processed fruit. Banana is a great economic importance in the moister areas of tropical agriculture and it is an important fruit crop in Malaysia as well. Banana is a soil conservative, productive, and non-seasonal fruits. It is sweet fruits which contains staple starch and other nutrition. In addition, there are some useful secondary products such as fibers, beverage, dyes, cordage and wrappings materials. The commercial plantations are consider revenues from exporting bananas (Noor, 2002).

Banana is a general term including a number of species in the genus *Musa* of the family *Musaceae*. There are two species in the section *Musa* which are *M. acuminate* and *M. balbisiana*. These cultivars are considered diploid that contain two sets of chromosomes. Therefore, the classification of *M. acuminate* and *M. balbisiana* are AA and BB groups respectively. In addition, *M. acuminate* and *M.*

balbisiana are edible bananas (Ortiz *et al.*, 1998; Robinso, 1996; Zhang *et al.*, 2005). *M. acuminate* developed primarily in tropical of Southeast Asia. Consequently, *Musa acuminata* (AA group) has been selected in this research.

Banana is considered very important for human diets. So, the quality of this fruit can significantly affect consumer appeal, handling practice, storage potential, and market selection. In addition, the ripening changes of banana might be influenced by storage temperature. It has been reported that the storage temperature of 16 °C to 18 °C may be the better commercial ripening of banana (Ahmad, *et al*. 2006). Therefore, the control of the ripening temperature is important to obtain the best quality fruit within in specific marketable life.

1.2 Problem Statement

The cultivar Papaya (*Carica papaya* L.) and Banana (*Musa acuminate*) are the widely grown in Malaysia. Malaysian fruits industry encounters problems in quality losses after storage of banana and papaya fruits due to the lack of knowledge on optimal storage during different durations. These issues such as weight loss, fruit ripening at shipping or storage periods which is attributed to temperature (Workneh *et al.*, 2012), fruit damage, loss of fruits quality such as nutrition, peel color, browning as well as microorganisms infestation (Gayosso-García *et al.*, 2010) which cause to become unhealthy food. Consequently, papaya and banana cultivars may be exposed to harmful bacteria and other contaminants prolonged storage periods as a result of inappropriate storage conditions. Therefore, the fruits can become a source of pathogens food. So, the contaminated fruit cannot be healthy food and cause diseases to human body. To date, there is currently limited scientific knowledge on the storage requirements to keep the high quality of (banana and papaya) fruits. The storage conditions are not convenient yet to guarantee the continuous supply of fresh and healthy fruits of acceptable standards to national and international markets. The storage conditions must be convenient to guarantee the continuous supply of fresh and healthy fruits of acceptable standards to national and international markets. The papaya and banana must be in good quality and good condition at market. In other

words, the fruits must be not over ripening, high rate of chilling injury, damage, infested fruits.

In addition, the fruits taste, texture and appearance may suffer as well. The fruits may lose their pharmaceutical properties and nutrition such a proteins, sugar, phenolics which are considered antioxidant compounds as a result of spoilage. In the current time, many diseases have been globally increasing. As a result of this, the consumption of fruits has been increased by human being because the research studies referring that fruits may help prevent particular sorts of illnesses, due to their potentially high antioxidant properties (Gayosso-García, *et al.,* 2010). Consequently, it is necessary to indicate that if fruit storage conditions are not convenience, metabolism accelerates and could exhaust its energetic reserves, resulting in the loss of nutritional value of the fruit (Gonzalez-Aguilar *et al.,* 2009; Gayosso-García, *et al.,* 2010). In this case, the technology of postharvest is essentially required to reserve the harvested fruits otherwise, the rate of deterioration of this produce might be augmented. Furthermore, the fruits cannot be satisfactory to customers which leads to reduce salesman income.

To develop quality standards for the export market, the knowledge of the optimum storage conditions are required to get more understanding of postharvest quality improves and consumer organoleptic perceptions. The Malaysian Papaya (*Carica papaya* L.) and Banana (*Musa acuminate*) industries are currently classed with fruit quality loss as a result of inappropriate storage. Currently, there has been a little scientific information on the storage requirements for the Malaysian *Papaya (Carica papaya L.)* and Banana (*Musa acuminate*). These fruits have been selected for this research because high rate of papaya and banana consumption at market (Fao and Foods, 2004; Ratule *et al.*, 2006). In order to take full support of the existing export market. Therefore, this study focused on storage to find out the optimum storage conditions for papaya and banana fruits.

1.3 Objectives of Research

The objectives of the study are as follows:

1. To evaluate papaya and banana fruits physico-chemical properties (weight loss, peel color), (TSS, TA, PH, TSS:TA, FPC), total polysaccharide and total protein content responses under different temperatures of storage and durations.
2. To evaluate the effect of temperature and storage period on the microbial growth in papaya and banana fruits.
3. To recommend the optimum storage conditions for papaya and banana fruits in tropical setting.

1.4 Scope of the Study

The domestic papaya and banana cultivars fruits are considered a common food in Malaysia. So, these fruits has been subjected to experimental evaluation in this research. Therefore, the scope of this research is to study the effects of different storage temperatures of 4 ±1, 10±2, 30±3 °C and durations of 0, 3, 6, 14, 30 days on physico-chemical properties of papaya and banana such as skin color of fruits, weight loss, soluble sugar, titratable acidity, pH, total soluble sugar to titratable acidity ratio and total phenolic concentration. In addition, the experiments has been conducted to evaluate the effectiveness of temperatures of 4 ±1, 10±2, 30±3 ºC and durations of 0, 3, 6, 14, 30 days on the total polysaccharide concentration and total protein content. The ambient conditions was selected because fruits are sold at most markets in this conditions and 4 and 10 °C were selected because this range have been tested for other foods in the previous studies. Furthermore, one of the most important study is the microorganisms contamination such as bacteria and fungus growth which has been investigated and correlated it to the temperatures of 4 ±1, 10±2, 30±3 °C and periods of 0, 3, 6, 14, 30 days.

1.5 Significance of the study

This study has focused on some factors that may have effectiveness such as temperature and time on the papaya and banana fruits into the storage. The deterioration of the food in the storage is an indicator to the responsible competent authorities to take into consideration the temperature and storage period and find out the best resolution to protect the stored products against deterioration, harmful bacteria, fungi, which cause diseases to human body as well as loss of quality and weight during storage and transportation.

Papaya and banana are considered nutritious fruits and consumed widely and particularly throughout tropical regions. Therefore, the accomplishment of this research would greatly contribute into the research community. The outcome of this research might provide a further insight into the stored papaya and banana fruits. Good comprehension study on total polysaccharide, protein estimation, total soluble sugar, titratable acidity (TA), pH, total phenolic content (FPC), fruits weight and microbial growth needed, consequently, it may improve this research approach on these parameters prolonged storage period and enable the authors to add more information to find out the convenient storage conditions. Extensive research on stored papaya and banana fruits can improve the probability of this study into a full scale large quantities of banana and papaya application in a near future in Malaysia.
Consequently, this significance of evaluation of total polysaccharide, protein estimation, total soluble sugar, titratable acidity (TA), pH, free phenolic content (FPC), fruits weight and microbial growth will surely become a factor of attraction in implementation in order to reduce losses, clean, fresh quality hygienic produce providing customer satisfaction, increase sale and increase farmer income which leads to improve marketing.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Papaya (*Carica papaya* L.) and Banana (*Musa acuminata*) are a tropical crops that capable to grow in different soil types (Sagnia *et al.*, 2014; Sahaa *et al.*, 2013). The commercial farming of papaya and banana fruit significantly increases, because it has multifunctional and nutritional benefit in the human diet, satisfying the medicinal of consumers in many countries (Finkel, 2003; Floyd, 1990; L. Huang *et al.*, 2011; S.-S. Huang *et al.*, 2013; Kumar *et al.*, 2012; Morris *et al.*, 2013; C. Rao *et al.*, 2007; Sripanidkulchai *et al.*, 2001; Valko *et al.*, 2007; Valko *et al.*, 2006). Therefore, the requirements are necessary for development of optimum postharvest storage conditions for papaya and banana. The literature review discussed the past and current knowledge on the effects of storage duration and temperature on sensory properties, nutritional composition and microbial growth of papaya and banana.

2.2 Papaya

Papaya is a fast growing tree that may reach three to ten meters high. It has only one stem without branches at initial growth. Some new shoots appear after about one year at the lower trunk and some branches may grow (Jiménez *et al.*, 2014). Figure 2.1 shows the papaya tree and fruits. The mass of leaves at the apex and along the top of the stem. The leaves are about fifty (50) to seventy (70) centimeter in diameter, deeply palmate lobed, with about seven to eleven lobes. The leaves contain white milk latex. Papaya flowers appear in the axils of leaves. The fruit is ripe when it feels soft and its skin has attained an amber to orange hue (Gross *et al.*, 2014; Nakasone and Paull, 1998).

Figure 2.1: Papaya tree and fruit (Jiménez *et al.*, 2014)

2.2.1 Papaya Maturity

The papaya fruits maturity can be determined by property of texture which include some characteristics such as firmness, color and latex. In addition, the taste of papaya can be one of the properties that determines the maturity of it. For example, sweetness, acidity and total soluble solid (TSS) (Basulto *et al*., 2009).

2.2.2 Skin Color of Papaya Fruits

The skin color of papaya can be used to determine its maturity. Figure 2.2 shows different stages of maturity papaya. These stages are classified by the skin color of papayas. Figure 2.2 (a1) and (a2) depict green skin without yellow stripe; pulp very hard and white in color; seeds well-formed but white or slightly dark in color. Figure 2.2 (b1) and (b2) show green skin with a light yellow stripe; pulp exhibits some areas with orange color, is very hard and contains large amounts of latex. Figure 2.2 (c1) and (c2) show green skin with well-defined yellow stripe; pulp is orange in color near seed cavity and light green near skin, although still hard and with large amounts of latex. Figure 2.2 (d1) and (d2) demonstrate one or more orange-colored stripes in skin; pulp almost completely orange in color, except near skin, still hard but contains less latex. Figure 2.2 (e1) and (e2) show skin clearly orange in color with some light green areas; pulp completely orange, except near peduncle, softer than in stage 3, but still too hard for consumption, low latex content. Figure 2.2 (f1) and (f2) show skin displays orange color characteristic of Maradol variety; pulp firmness appropriate for consumption, latex no longer present. Figure 2.2 (g1) and (g2) depict the conditions similar to stage 5, but with more intense orange color in skin and softer pulp still adequate for consumption (Basulto *et al*., 2009).

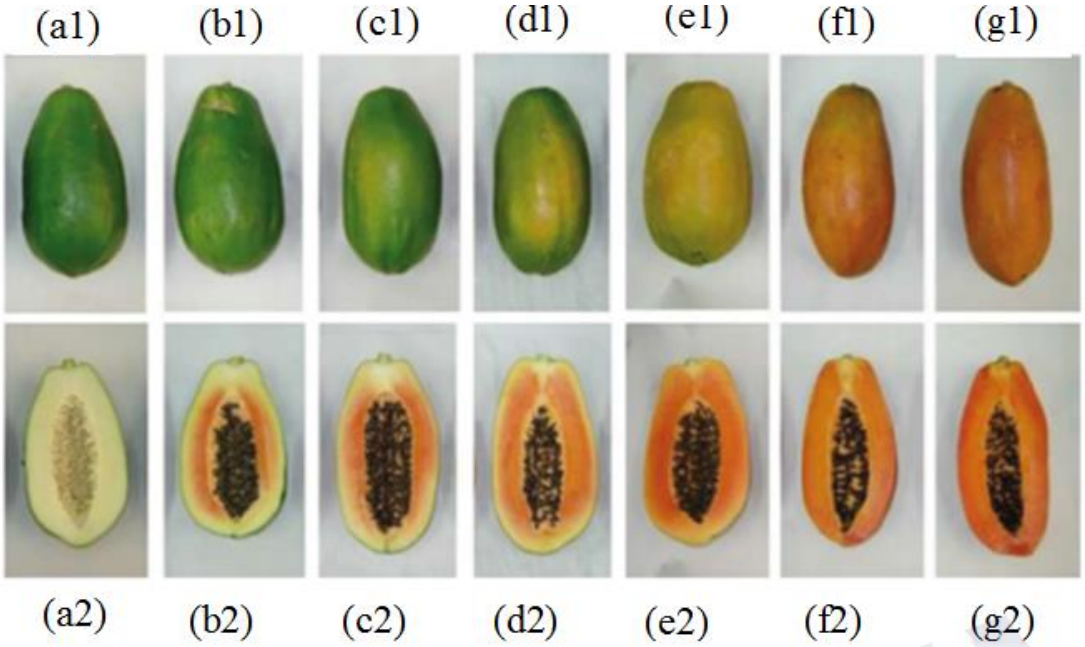

Figure 2.2: Papayas maturity stage description (Basulto *et al.*, 2009)

2.3 Banana

The word banana is a general term embracing a number of species or hybrids in the genus *Musa* of the family *Musaceae* (Zhang *et al.*, 2005). Banana cultivars are yellow when it is ripe. Consequently, the ripe banana may be damaged and lost its quality during transportation from farm to the market. Banana is one of important foods that source of energy, mineral salts and vitamins. Furthermore, sensorial attributes of the banana, as flavor, taste, texture, and color, are significantly influenced by its chemical composition, especially by acids, sugars, and phenolic compounds (Carvalho *et al.*, 2009).

The potential life of fruit after harvest depends on factors such as maturity, care and storage conditions (airflow and temperature). Several pre-harvest parameters may indeed contribute to successful development of good quality fruit and vegetables. Agricultural practices, soil, climate and harvesting conditions all affect the banana. The disease effectiveness such as *Fusarium* wilts and damages banana leafs (Jamaluddin, 2000). Usually, such disease outbreaks in bananas which associated with the presence of plant-parasitic nematodes in the cultivation areas, as

REFERENCES

Abeywickrama, K., Wijerathna, C., Rajapaksha, N., Sarananda, K., & Kannangara, S. (2012). Disease Control Strategies for Extending Storage Life of Papaya (Carica papaya), Cultivars' Red Lady'and'Rathna'. *Ceylon Journal of Science (Biological Sciences*), 41(1).

Abuhamra, S. G. A. (2016). Effects of Different Storage Temperatures and Durations on Physiochemical Properties and Nutritional Composition of Banana and Papaya. *Journal of Biotechnology Science Research*, *3*(3).

Agar, I., Massantini, R., Hess-Pierce, B. and Kader, A. (1999). Postharvest CO2 and Ethylene Production and Quality Maintenance of Fresh-Cut Kiwifruit Slices. *Journal of Food Science*, 64(3), 433-440.

Ahmad, S. A. E. E. D., Perviez, M. A., Chatha, A., & Thompson, A. K. (2006). Improvement of Banana Quality in Relation to Storage Humidity, Temperature and Fruit Length. *International Journal of Agriculture and Biology*, 8, 377-380.

Ahmed, J., Shivhare, U. and Debnath, S. (2002). Color Degradation and Rheology of Green Chilli Puree during Thermal Processing. *International Journal of Food Science & Technology*, 37(1), 57-63.

Alasalvar, C., Grigor, J. M., Zhang, D., Quantick, P. C. and Shahidi, F. (2001). Comparison of Volatiles, Phenolics, Sugars, Antioxidant Vitamins, and Sensory Quality of Different Colored Carrot Varieties. *Journal of Agricultural and Food Chemistry*, 49(3), 1410-1416.

Almeida, M. M. B., de Sousa, P. H. M., Arriaga, Â. M. C., do Prado, G. M., de Carvalho Magalhães, C. E., Maia, G. A., & de Lemos, T. L. G. (2011). Bioactive Compounds and Antioxidant Activity of Fresh Exotic Fruits from Northeastern Brazil. *Food Research International*, 44(7), 2155-2159.

Ali, A., Muhammad, M. T. M., Sijam, K., and Siddiqui, Y. (2011). Effect of Chitosan Coatings on the Physicochemical Characteristics of Eksotika II Papaya (Carica Papaya L.) Fruit during Cold Storage. *Food Chemistry*, 124(2), 620-626.

Almora, K., Pino, J. A., Hernandez, M., Duarte, C., González, J. and Roncal, E. (2004). Evaluation of Volatiles from Ripening Papaya (Carica Papaya L., var. Maradol roja). *Food Chemistry*, 86(1), 127-130.

Alvarez, A. M., & Nishijima, W. T. (1987). Postharvest Diseases of Papaya. *Plant Disease*, 71(8), 681-686.

Amankwah, E., Barimah, J., Nuamah, A., Oldham, J., Nnaji, C. and Knust, P. (2009). Formulation of Weaning Food from Fermented Maize, Rice, Soybean and Fishmeal. *Pakistan Journal of Nutrition*, 8(11), 1747-1752.

Anyasi, T. A., Jideani, A. I. and Mchau, G. A. (2015). Morphological, Physicochemical, and Antioxidant Profile of Noncommercial Banana Cultivars. *Food Science & Nutrition*, 3(3), 221-232.

Anyasi, T. A., Jideani, A. I. and Mchau, G. R. (2013). Functional Properties and Postharvest Utilization of Commercial and Noncommercial Banana Cultivars. *Comprehensive Reviews in Food Science and Food Safety*, 12(5), 509-522.

ARĔAS, J. A. G. and LAJOLO, F. (1981). Starch Transformation during Banana Ripening: I—The Phosphorylase and Phosphatase Behavior in Musa Acuminata. *Journal of Food Biochemistry*, 5(1), 19-37.

Arendse, E., Fawole, O. A., & Opara, U. L. (2015). Discrimination of Pomegranate Fruit Quality by Instrumental and Sensory Measurements during Storage at Three Temperature Regimes. *Journal of Food Processing and Preservation*, 39(6), 1867-1877

Awoyale, W., Sanni, L. O., Shittu, T. A. and Adegunwa, M. O. (2015). Effect of Storage on the Chemical Composition, Microbiological Load, and sensory Properties of Cassava Starch-Based Custard Powder. *Food Science & Nutrition*. 3(5), 425-433

Ayala-Zavala, J. F., Wang, S. Y., Wang, C. Y. and González-Aguilar, G. A. (2004). Effect of Storage Temperatures on Antioxidant Capacity and Aroma Compounds in Strawberry Fruit. *LWT-Food Science and Technology*, 37(7), 687-695.

Azarkan, M., El Moussaoui, A., Van Wuytswinkel, D., Dehon, G. and Looze, Y. (2003). Fractionation and Purification of the Enzymes Stored in the Latex of Carica Papaya. *Journal of Chromatography B*, 790(1), 229-238.

Babsky, N., Toribio, J. and Lozano, J. (1986). Influence of Storage on the Composition of Clarified Apple Juice Concentrate. *Journal of Food Science*, 51(3), 564-567.

Baldwin, E. A., Scott, J. W., Einstein, M. A., Malundo, T. M. M., Carr, B. T., Shewfelt, R. L., & Tandon, K. S. (1998). Relationship between Sensory and Instrumental Analysis for Tomato Flavor. *Journal of the American Society for Horticultural Science*, 123(5), 906-915.

Ball, D. W. (2006). Concentration Scales for Sugar Solutions. *J. Chem. Educ*, 83(10), 1489.

Barriga, M., Trachy, G., Willemot, C. and Simard, R. (1991). Microbial Changes in Shredded Iceberg Lettuce Stored under Controlled Atmospheres. *Journal of Food Science*, 56(6), 1586-1588.

Bassinello, P. Z., Cordenunsi, B. R. and Lajolo, F. M. (2002). Amylolytic Activity in Fruits: Comparison of Different Substrates and Methods using Banana as Model. *Journal of Agricultural and Food Chemistry*, 50(21), 5781-5786.

Basulto, F. S., Duch, E. S., y-Gil, F. E., Diaz Plaza, R., Saavedra, A. L., & Santamaría, J. M. (2009). Postharvest Ripening and Maturity Indices for Maradol Papaya. *Interciencia*, 34(8), 583.

Bayram, E., Dundar, O. and Ozkaya, O. (2006). Effect of Different Packaging Types on Storage of Hicaznar Pomegranate Fruits. *Proceedings of the 2006 I International Symposium on Pomegranate and Minor Mediterranean Fruits*, 818, 319-322.

Bico, S., Raposo, M., Morais, R. and Morais, A. (2009). Combined Effects of Chemical Dip and/or Carrageenan Coating and/or Controlled Atmosphere on Quality of Fresh-Cut Banana. *Food Control*, 20(5), 508-514.

Bico, S. L. S., Raposo, M. F. J., Morais, R. M. S. C. and Morais, A. M. M. B. (2009). Combined Effects of Chemical Dip and/or Carrageenan Coating and/or Controlled Atmosphere on Quality of Fresh-Cut Banana. *Food Control*, 20(5), 508-514.

Bron, I. U. and Jacomino, A. P. (2006). Ripening and Quality of'golden'papaya Fruit Harvested at Different Maturity Stages. *Brazilian Journal of Plant Physiology*, 18(3), 389-396.

Bunea, A., Socaciu, C., and Pintea, A. (2014). Xanthophyll Esters in Fruits and Vegetables. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 42(2), 310.

Cámara, M., Diez, C. and Torija, M. (1993). Changes during Ripening of Papaya Fruit in Different Storage Systems. *Food Chemistry*, 46(1), 81-84.

Carlin, F., Nguyenthe, C., Cudennec, P. and Reich, M. (1989). Microbiological Spoilage of Fresh, Ready-To-Use Grated Carrots. *Sciences des Aliments*, 9(2), 371-386.

Carvalho, G. B., Silva, D. P., Santos, J. C., Izário Filho, H. J., Vicente, A. A., Teixeira, J. A., and Silva, J. B. A. (2009). Total Soluble Solids from Banana: Evaluation and Optimization of Extraction Parameters. *Applied Biochemistry and Biotechnology*, 153(1-3), 34-43.

Chan, Y. K. (2009). Breeding Papaya (Carica papaya L.). in Breeding Plantation Tree Crops: Tropical Species (pp. 121-159). Springer New York.

Chemists, A. A. (1990). Official Methods of Analysis. Vol. I. 15th ed. AOAC, Arlington, VA.

Choo, C. L. and Aziz, N. A. A. (2010). Effects of Banana Flour and β-glucan on the Nutritional and Sensory Evaluation of Noodles. *Food Chemistry*, 119(1), 34-40.

Chope, G. A., Terry, L. A., and White, P. J. (2007). The Effect of the Transition between Controlled Atmosphere and Regular Atmosphere Storage on Bulbs of Onion Cultivars SS1, Carlos and Renate. *Postharvest Biology and Technology*, 44(3), 228-239.

Connor, A. M., Luby, J. J., Hancock, J. F., Berkheimer, S. and Hanson, E. J. (2002). Changes in Fruit Antioxidant Activity among Blueberry Cultivars during Cold-Temperature Storage. *Journal of Agricultural and Food Chemistry*, 50(4), 893-898.

Coombe, B. G., Dundon, R. J., and Short, A. W. (1980). Indices of Sugar—Acidity as Ripeness Criteria for Winegrapes. *Journal of the Science of Food and Agriculture*, 31(5), 495-502.

da Silva, J. T., Rashid, Z., Nhut, D. T., Sivakumar, D., Gera, A., Souza Jr, M. T., (2007). Papaya (Carica papaya L.) Biology and Biotechnology. *Tree and Forestry Science and Biotechnology*, 1(1), 47-73.

De Oliveira, J. G. and Vitória, A. P. (2011). Papaya: Nutritional and Pharmacological Characterization, and Quality Loss due to Physiological Disorders. An Overview. *Food Research International*, 44(5), 1306-1313.

Der Agopian, R. G., Peroni-Okita, F. H. G., Soares, C. A., Mainardi, J. A., do Nascimento, J. R. O., Cordenunsi, B. R.,. (2011). Low Temperature Induced Changes in Activity and Protein Levels of the Enzymes Associated to Conversion of Starch to Sucrose in Banana Fruit. *Postharvest Biology and Technology*, 62(2), 133-140.

Do Nascimento, J. R. O., Júnior, A. V., Bassinello, P. Z., Cordenunsi, B. R., Mainardi, J. A., Purgatto, E.,. (2006). Beta-amylase Expression and Starch Degradation during Banana Ripening. *Postharvest Biology and Technology*, 40(1), 41-47.

Dominguez-Puigjaner, E., Vendrell, M. and Ludevid, M. D. (1992). Differential Protein Accumulation in Banana Fruit during Ripening. *Plant Physiology*, 98(1), 157-162.

Dongare, M. L., Buchade, P. B., Awatade, M. N., and Shaligram, A. D. (2014). Mathematical Modeling and Simulation of Refractive Index Based Brix Measurement System. *Optik-International Journal for Light and Electron Optics*, 125(3), 946-949.

Downes, F. P. and Ito, K. (2001). Compendium of Methods for the Microbiological Examination of Foods American Public Health Association. Washington, DC, 473-481.

Echeverria, E. D., and Ismail, M. (1987). Changes in Sugars and Acids of Citrus Fruits During Storage. In Proc. Fla. State Hort. Soc (Vol. 100, pp. 50-52).

Englyst, H. N. and Cummings, J. H. (1986). Digestion of the Polysacchariedof Banana (Musa Paradisiaca Sapientum) in the Human Small Intestine. *The American Journal of Clinical Nutrition*, 44(1), 42-50.

Elsamadony, M., Tawfik, A., Danial, A., & Suzuki, M. (2015). Use of Carica Papaya Enzymes for Enhancement of H 2 Production and Degradation of Glucose, Protein, and Lipids. Energy Procedia, 75, 975-980.

Evans, E. A., & Ballen, F. H. (2012). An Overview of Global Papaya Production, Trade, and Consumption. Gainesville: University of Florida.

Ewaidah, E. (1992). Studies on Commercially Canned Juices Produced Locally in Saudi Arabia: Part 3—Physicochemical, Organoleptic and Microbiological Assessment. Food Chemistry, 44(2), 103-111.

Facundo, H. V. D. V., Gurak, P. D., Mercadante, A. Z., Lajolo, F. M., & Cordenunsi, B. R. (2015). Storage at Low Temperature Differentially Affects the Color and Carotenoid Composition of Two Cultivars of Banana. *Food Chemistry*, 170, 102-109.

Falah, M. A. F., Nadine, M. D., & Suryandono, A. (2015). Effects of Storage Conditions on Quality and Shelf-life of Fresh-cut Melon (Cucumis Melo L.) and Papaya (Carica Papaya L.). *Procedia Food Science*, 3, 313-322.

Fao, J. and Foods, M. H. I. (2004). Food and Agriculture Organization of the United Nations. Rome, URL: http://faostat. fao. Org.

Fawole, O. A., and Opara, U. L. (2013). Effects of Storage Temperature and Duration on Physiological Responses of Pomegranate Fruit. *Industrial Crops and Products*, 47, 300-309.

Finkel, T. (2003). Oxidant Signals and Oxidative Stress. Current Opinion in Cell Biology, 15(2), 247-254.

Floyd, R. A. (1990). Role of Oxygen Free Radicals in Carcinogenesis and Brain Ischemia. *The FASEB Journal*, 4(9), 2587-2597.

Francis, F. (1995). Quality as Influenced by Color. *Food Quality and Preference*, 6(3), 149-155.

Gerhardt, P., Murray, R., Wood, W. A. and Krieg, N. R. (1994). Methods for General and Molecular Bacteriology (Vol. 1325): American Society for Microbiology Washington, DC.

Gol, N. B. and Ramana Rao, T. (2011). Banana Fruit Ripening as Influenced by Edible Coatings. *International Journal of Fruit Science*, 11(2), 119-135.

Gonzalez-Aguilar, G. A., Buta, J. G., & Wang, C. Y. (2003). Methyl Jasmonate and Modified Atmosphere Packaging (MAP) Reduce Decay and Maintain Postharvest Quality of Papaya 'Sunrise'. *Postharvest Biology and Technology*, 28(3), 361-370.

Gonzalez-Aguilar, G., Fortiz, J., Cruz, R., Baez, R. and Wang, C. (2000). Methyl Jasmonate Reduces Chilling Injury and Maintains Postharvest Quality of Mango Fruit. *Journal of Agricultural and Food Chemistry*, 48(2), 515-519.

González-Aguilar, G., Ruiz-Cruz, S., Cruz-Valenzuela, R., Rodrıguez-Félix, A. and Wang, C. (2004). Physiological and Quality Changes of Fresh-Cut Pineapple Treated with Antibrowning Agents. *LWT-Food Science and Technology*, 37(3), 369-376.

Gonzalez-Aguilar, G. A., Celis, J., Sotelo-Mundo, R. R., De La Rosa, L. A., Rodrigo-Garcia, J. and Alvarez-Parrilla, E. (2008). Physiological and Biochemical Changes of Different Fresh-Cut Mango Cultivars Stored at 5° C. *International Journal of Food Science & Technology*, 43(1), 91-101.

Gorny, J., Cifuentes, R., Hess-Pierce, B. and Kader, A. (2000). Quality Changes in Fresh-Cut Pear Slices as Affected by Cultivar, Ripeness Stage, Fruit Size, and Storage Regime. *Journal of Food Science*, 65(3), 541-544.

Goswami, B. and Borthakur, A. (1996). Chemical and Biochemical Aspects of Developing Culinary Banana (Musa ABB) 'Kachkal'. *Food Chemistry*, 55(2), 169-172.

Gross, K.C., Wang, C.Y. and Saltveit, M., (2004). The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks. *Agriculture Handbook*, 66.

Huang, L., Guan, T., Qian, Y., Huang, M., Tang, X., Li, Y., (2011). Anti-Inflammatory Effects of Maslinic Acid, A Natural Triterpene, in Cultured Cortical Astrocytes Via Suppression of Nuclear Factor-Kappa B. *European Journal of Pharmacology*, 672(1), 169-174.

Huang, S.-S., Chiu, C.-S., Lin, T.-H., Lee, M.-M., Lee, C.-Y., Chang, S.-J., (2013). Antioxidant and Anti-Inflammatory Activities of Aqueous Extract of Centipeda Minima. *Journal of Ethnopharmacology*, 147(2), 395-405.

Irtwange, S. V. (2006). Application of Modified Atmosphere Packaging and Related Technology in Postharvest Handling of Fresh Fruits and Vegetables. *Agricultural Engineering International: CIGR Journal*. Invited Overview No. 4. Vol. VIII.

Islam, M. S., Islam, M. S. and Kabir, A. (2001). Effect of Postharvest Treatments with Some Coating Materials on the Shelf Life and Quality of Banana. *Pakistan J. Biol. Sci*, 4, 1149-1152.

Jacob, D. (2014). Advances in Temperate Fruit Production: Oxford Book Company.

Jamaluddin, S. H. (2000). Banana R&D thrusts in Malaysia. *Advancing Banana and Plantain R & D in Asia and the Pacific*, 108-111..

Jayasena, V., and Cameron, I. (2008). °Brix/acid Ratio as a Predictor of Consumer Acceptability of Crimson Seedless Table Grapes. *Journal of Food Quality*, 31(6), 736-750.

Jiménez, V. M., Mora-Newcomer, E., & Gutiérrez-Soto, M. V. (2014). Biology of the Papaya Plant. In *Genetics and Genomics of Papaya* (pp. 17-33). Springer New York

Johnson, G.I. and Hofman, P.J., (2009). 15 Postharvest Technology and Quarantine Treatments. ResearchGate.

Jordan, R. B., Seelye, R. J., & McGlone, V. A. (2001). A Sensory-Based Alternative to Brix/Acid Ratio. *Food Technology*, 55(6), 36-44.

Kader, A.A., (2003). A Perspective on Postharvest Horticulture (1978-2003). *HortScience*, 38(5), .1004-1008.

Kader, A. A., Hess-Pierce, B., and Almenar, E. (2003). Relative Contributions of Fruit Con-Stituents to Total Soluble Solids Content Measured by Refractometer. *HortScience*, 38, 383.

Kader, A.A. and Rolle, R.S., 2004. The Role of Post-Harvest Management in Assuring the Quality and Safety of Horticultural Produce (Vol. 152). Food & Agriculture Org.

Kaplan, F., Sung, D. Y. and Guy, C. L. (2006). Roles of β-amylase and Starch Breakdown during Temperatures Stress. *Physiologia Plantarum*, 126(1), 120-128.

Karakurt, Y. and Huber, D. J. (2003). Activities of Several Membrane and Cell-Wall Hydrolases, Ethylene Biosynthetic Enzymes, and Cell Wall Polyuronide Degradation During Low-Temperature Storage of Intact and Fresh-Cut Papaya (Carica papaya) Fruit. *Postharvest Biology and Technology*, 28(2), 219-229.

Kamdem, I., Hiligsmann, S., Vanderghem, C., Bilik, I., Paquot, M., & Thonart, P. (2013). Comparative Biochemical Analysis during the Anaerobic Digestion of Lignocellulosic Biomass from Six Morphological Parts of Williams Cavendish Banana (Triploid Musa AAA group) Plants. *World Journal of Microbiology and Biotechnology*, 29(12), 2259-2270.

Kumar, H., Koppula, S., Kim, I.-S., Vasant More, S., Kim, B.-W. and Choi, D.-K. (2012). Nuclear Factor Erythroid 2-Related Factor 2 Signaling in Parkinson Disease: A Promising Multi Therapeutic Target Against Oxidative Stress, Neuroinflammation and Cell Death. *CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders)*, 11(8), 1015-1029.

Lamikanra, O., Chen, J., Banks, D. and Hunter, P. (2000). Biochemical and Microbial Changes during the Storage of Minimally Processed Cantaloupe. *Journal of Agricultural and Food Chemistry*, 48(12), 5955-5961.

Lante, A., Tinello, F., and Nicoletto, M. (2016). UV-A Light Treatment for Controlling Enzymatic Browning of Fresh-Cut Fruits. *Innovative Food Science & Emerging Technologies*, 34, 141-147.

Lazan, H., Selamat, M. and Ali, Z. M. (1995). β-Galactosidase, Polygalacturonase and Pectinesterase in Differential Softening and Cell Wall Modification during Papaya Fruit Ripening. *Physiologia Plantarum*, 95(1), 106-112.

Li, C. and Kader, A. A. (1989). Residual Effects of Controlled Atmospheres on Postharvest Physiology and Quality. *Journal of the American Society for Horticultural Science*, 114, 629-634.

E Silva, P. S. L., Antonio, R. P., and de Sousa Nunes, G. H. (2006). Juice Extraction for Total Soluble Solids Content Determination in Melon. *Caatinga*, 19(3), 268-271.

Lis, J.A., Becker, M. and Schaefer, C.W., (2000). Burrower Bugs (Cydnidae). Heteroptera of Economic Importance. *CRC, Boca Raton*, pp.405-419.

Lichanporn, I. and Kanlavanarat, S. (2006). Effect of Organic Acid and Modified Atmosphere Conditions on Quality of Shredded Green Papaya (Carica Papaya L.). *Proceedings of the 2006 IV International Conference on Managing Quality in Chains-The Integrated View on Fruits and Vegetables Quality*, 712, 729-734.

Magalhães, L. M., Santos, F., Segundo, M. A., Reis, S. and Lima, J. L. (2010). Rapid Microplate High-Throughput Methodology for Assessment of Folin-Ciocalteu Reducing Capacity. *Talanta*, 83(2), 441-447.

Magwaza, L. S., and Opara, U. L. (2015). Analytical Methods for Determination of Sugars and Sweetness of Horticultural Products—A Review. *Scientia Horticulturae*, 184, 179-192.

Markwell, M. A. K., Haas, S. M., Bieber, L. L. and Tolbert, N. E. (1978). A Modification of the Lowry Procedure to Simplify Protein Determination in Membrane and Lipoprotein Samples. *Analytical Biochemistry*, 87(1), 206-210.

Martinez-Ferrer, M., Harper, C., Pérez-Muñoz, F. and Chaparro, M. (2002). Modified Atmosphere Packaging of Minimally Processed Mango and Pineapple Fruits. *Journal of Food Science-Chicago*, 67(9), 3365-3371.

Maqbool, M., Ali, A., Alderson, P. G., Mohamed, M. T. M., Siddiqui, Y., & Zahid, N. (2011). Postharvest Application of Gum Arabic and Essential Oils for Controlling Anthracnose and Quality of Banana and Papaya during Cold Storage. *Postharvest Biology and Technology*, 62(1), 71-76.

Medina, J. D. L. C., Gutiérrez, G. V., & García, H. S. (2003). Pawpaw: Post-harvest operation. *Food and Agriculture Organization*, 31.

Ming, R., Yu, Q., Moore, P. H., Paull, R. E., Chen, N. J., Wang, M. L., & Paterson, A. H. (2012). Genome of Papaya, a Fast Growing Tropical Fruit Tree. *Tree Genetics & Genomes*, 8(3), 445-462.

Mitra, S. K. (1997). Postharvest Physiology and Storage of Tropical and Subtropical Fruits. (pp.167-189). UK: CAB International.

Morris, D., Khurasany, M., Nguyen, T., Kim, J., Guilford, F., Mehta, R., (2013). *Glutathione and Infection. Biochimica et Biophysica Acta (BBA)-General Subjects*, 1830(5), 3329-3349.

Müller, R., Sisler, E. C., & Serek, M. (2000). Stress Induced Ethylene Production, Ethylene Binding, and The Response to the Ethylene Action Inhibitor 1-MCP in Miniature Roses. *Scientia Horticulturae*, 83(1), 51-59.

Ng, F. (2015). Breeding the Papaya-Carica Papaya. *Utar Agriculture Science Journal*. Vol. 1 No. 2. 32-42

Nguyen-the, C. and Prunier, J. (1989). Involvement of Pseudomonads in Deterioration or 'Ready-to-Use' Salads. *International Journal of Food Science & Technology*, 24(1), 47-58.

Nishijima, K., Couey, H. and Alvarez, A. (1987). Internal Yellowing, a Bacterial Disease of Papaya Fruits Caused by Enterobacter Cloacae. Plant Disease, 71(11), 1029-1034.

Noor, M. I. (2002). The Nutrition and Health Transition in Malaysia. *Public Health Nutrition*, 5(1a), 191-195.

Nunes, M., Emond, J. and Brecht, J. (2006). Brief Deviations from Set Point Temperatures during Normal Airport Handling Operations Negatively Affect the Quality of Papaya (Carica Papaya) Fruit. *Postharvest Biology and Technology*, 41(3), 328-340.

O'CONNOR-SHAW, R., Roberts, R., Ford, A. and Nottingham, S. (1994). Shelf life of Minimally Processed Honeydew, Kiwifruit, Papaya, Pineapple and Cantaloupe. *Journal of Food Science*, 59(6), 1202-1206.

Oloyede, O. (2005). Chemical Profile of Unripe Pulp of Carica Papaya. *Pakistan Journal of Nutrition*, 4(6), 379-381.

Ortega, M. M. G. (2011). Effect of Proteolytic Enzyme and Fiber of Papaya Fruit on Human Digestive Health. Doctoral Dissertation, University of Illinois at Urbana-Champaign. p 10-11

Ortiz, R., Madsen, S. and Vuylsteke, D. (1998). Classification of African Plantain Landraces and Banana Cultivars using a Phenotypic Distance Index of Quantitative Descriptors. *Theoretical and Applied Genetics*, 96(6-7), 904-911.

Patapanian, E. and Rieves, C., Patapanian, Edward, Rieves and Cheryl, (1997). Gas Permeable Envelope with Ethylene Absorbing Chemicals Packaged in Airtight Container, for Controlling Ripening of Fruits and Vegetables. U.S. Patent 5,624,478.

Parniakov, O., Roselló-Soto, E., Barba, F. J., Grimi, N., Lebovka, N., & Vorobiev, E. (2015). New Approaches for the Effective Valorization of Papaya Seeds: Extraction of Proteins, Phenolic Compounds, Carbohydrates, and Isothiocyanates Assisted by Pulsed Electric Energy. *Food Research International*, 77, 711-717.

Parris, G. K. (1938). A New Disease of Papaya in Hawaii. *Proceedings of the 1938 Proceedings of the American Society for Horticultural Science*, 263-265.

Pathare, P. B., Opara, U. L. and Al-Said, F. A.-J. (2013a). Color Measurement and Analysis in Fresh and Processed Foods: A Review. *Food and Bioprocess Technology*, 6(1), 36-60.

Pathare, P. B., Opara, U. L. and Al-Said, F. A.-J. (2013b). Proceedings of the American Society for Horticultural Science. *Food and Bioprocess Technology*, 6(1), 36-60.

Paull, R. E., Gross, K. and Qiu, Y. (1999). Changes in Papaya Cell Walls during Fruit Ripening. *Postharvest Biology and Technology*, 16(1), 79-89.

Pilar Cano, M., de Ancos, B., Gloria Lobo, M. and Monreal, M. (1996). Carotenoid Pigments and Color of Hermaphrodite and Female Papaya Fruits (Carica papaya L) cv Sunrise During Post-Harvest Ripening. *Journal of the Science of Food and Agriculture*, 71(3), 351-358.

Pinto, J. A. V., Schorr, M. R. W., Thewes, F. R., Ceconi, D. L., Both, V., Brackmann, A., and Fronza, D. (2015). Relative Humidity during Cold Storage on Postharvest Quality of Niagara Rosada Table Grapes. *Ciência Rural*, 45(3), 386-391.

Ploetz, R. C. (2007). Diseases of Tropical Perennial Crops: Challenging Problems in Diverse Environments. Plant Disease, 91(6), 644-663.

Praeger, U., Linke, M., Jedermann, R., Moehrke, A., Geyer, M., and BVBA, D. E. I. (2013). Effect of Storage Climate on Green-Life Duration of Bananas. In 5th International Workshop Cold Chain Management, Bonn, Germany, University Bonn.

Rahman, S. S. A., Zain, S. M., Mat, M. B., Sidam, A. K., Othman, R. Y., & Mohamed, Z. (2014). Population Distribution of Plant-parasitic Nematodes of Bananas in Peninsular Malaysia. *Sains Malaysiana*, 43(2), 175-183.

Rao, C., Verma, A., Gupta, P. and Vijayakumar, M. (2007). Anti-Inflammatory and Anti-Nociceptive Activities of Fumaria Indica Whole Plant Extract in Experimental Animals. *Acta Pharmaceutica*, 57(4), 491-498.

Rahman, M. A., Mahmud, T. M. M., Kadir, J., Abdul Rahman, R., & Begum, M. M. (2008). Major Postharvest Fungal Diseases of Papaya cv. Sekaki in Selangor, Malaysia. *Pertanika Journal of Tropical Agricultural Science*, 31(1), 27-34.

Ratule, M., Osman, A., Ahmad, S. and Saari, N. (2006). Development of Chilling Injury of 'Berangan'banana (Musa cv. Berangan (AAA)) during Storage at Low Temperature. *Journal of Food, Agriculture & Environment*, 4(1), 128-134.

Raybaudi-Massilia, R., Calderón-Gabaldón, M. I., Mosqueda-Melgar, J., & Tapia, M. S. (2013). Inactivation of Salmonella enterica ser. Poona and Listeria Monocytogenes on Fresh-Cut "Maradol" Red Papaya (Carica papaya L) treated with UV-C Light and Malic Acid. *Journal für Verbraucherschutz und Lebensmittelsicherheit*, 8(1-2), 37-44.

Rivera-López, J., Vázquez-Ortiz, F. A., Ayala-Zavala, J. F., Sotelo-Mundo, R. R., and González-Aguilar, G. A. (2005). Cutting Shape and Storage Temperature Affect Overall Quality of Fresh-Cut Papaya cv. 'Maradol'. *Journal of Food Science*, 70(7), s482-s489.

Rivera-Pastrana, D. M., Yahia, E. M. and González-Aguilar, G. A. (2010). Phenolic and Carotenoid Profiles of Papaya Fruit (Carica Papaya L.) and Their Contents under Low Temperature Storage. *Journal of the Science of Food and Agriculture*, 90(14), 2358-2365.

Robinso, J. (1996). Distribution and Importance; Taxonomic Classification, Cultivars and Breeding. Banana and Plantains. Wallingford: CAB International, 1-33.

Rocha, A., Nunes, M. C., Morais, A. and DE, M. M. B. (2000). Effects of controlled Atmosphere on Quality of Minimally Processed Apple (cv. Jonagored). *Journal of Food Processing and Preservation*, 24(6), 435-451.

Roongruangsri, W., Rattanapanone, N., Leksawasdi, N., & Boonyakiat, D. (2013). Influence of Storage Conditions on Physico-Chemical and Biochemical of Two Tangerine Cultivars. *Journal of Agricultural Science*, 5(2), 70.

Rossmann, B., Müller, H., Smalla, K., Mpiira, S., Tumuhairwe, J. B., Staver, C., (2012). Banana-associated Microbial Communities in Uganda are Highly Diverse but Dominated by Enterobacteriaceae. *Applied and Environmental Microbiology*, 78(14), 4933-4941.

Sagnia, B., Fedeli, D., Casetti, R., Montesano, C., Falcioni, G. and Colizzi, V. (2014). Antioxidant and Anti-Inflammatory Activities of Extracts from Cassia alata, Eleusine indica, Eremomastax Speciosa, Carica Papaya and Polyscias fulva Medicinal Plants Collected in Cameroon. *PloS One*, 9(8), e103999.

Sahaa, R. K., Acharyaa, S., Shovon, S. S. H. and Royb, P. (2013). Medicinal Activities of the Leaves of Musa Sapientum var. Sylvesteris in vitro. *Asian Pacific Journal of Tropical Biomedicine*, 3(6), 476-482.

Salunkhe, D. K., Bolin, H. R. and Reddy, N. R. (1991). *Processing and Nutritional Quality of Fruits and Vegetables*. 2nd Edition Vol. 1. CRC Press, Boca Raton, Florida

Sancho, L. E. G.-G., Yahia, E. M. and González-Aguilar, G. A. (2011). Identification and Quantification of Phenols, Carotenoids, and Vitamin C from Papaya

(Carica papaya L., cv. Maradol) fruit determined by HPLC-DAD-MS/MS-ESI. *Food Research International*, 44(5), 1284-1291.

Schweiggert, R. M., Steingass, C. B., Mora, E., Esquivel, P. and Carle, R. (2011). Carotenogenesis and Physico-Chemical Characteristics during Maturation of Red Fleshed Papaya Fruit (Carica papaya L.). *Food Research International*, 44(5), 1373-1380.

Sharma, R. R., Singh, D., & Singh, R. (2009). Biological Control of Postharvest Diseases of Fruits and Vegetables by Microbial Antagonists: A Review. *Biological Control*, 50(3), 205-221.

Smith, R. (2015). Banana Production in Greenhouses. University of Minnesota: Ph.D. Thesis

Sripanidkulchai, B., Wongpanich, V., Laupattarakasem, P., Suwansaksri, J. and Jirakulsomchok, D. (2001). Diuretic Effects of Selected Thai Indigenous Medicinal Plants in Rats. *Journal of Ethnopharmacology*, 75(2), 185-190.

Srisuvor, N., Prakitchaiwattana, C., Chinprahast, N. and Subhimaros, S. (2013). Use of Banana Purée from Three Indigenous Thai Cultivars as Food Matrices for Probiotics and Application in Bio-Set-Type Yoghurt Production. International Journal of Food Science & Technology, 48(8), 1640-1648.

Subedi, P. P., & Walsh, K. B. (2011). Assessment of Sugar and Starch in Intact Banana and Mango Fruit by SWNIR Spectroscopy. *Postharvest Biology and Technology*, 62(3), 238-245.

Tripathi, S., Suzuki, J. Y., Carr, J. B., McQuate, G. T., Ferreira, S. A., Manshardt, R. M., (2011). Nutritional Composition of Rainbow Papaya, the First Commercialized Transgenic Fruit Crop. *Journal of Food Composition and Analysis*, 24(2), 140-147.

Valko, M., Leibfritz, D., Moncol, J., Cronin, M. T., Mazur, M. and Telser, J. (2007). Free Radicals and Antioxidants in Normal Physiological Functions and Human Disease. *The International Journal of Biochemistry & Cell Biology*, 39(1), 44-84.

Valko, M., Rhodes, C., Moncol, J., Izakovic, M. and Mazur, M. (2006). Free Radicals, Metals and Antioxidants in Oxidative Stress-Induced Cancer. *Chemico-Biological Interactions*, 160(1), 1-40.

Vitali, A. A. and Rao, M. A. (1984). Flow Properties of Low-Pulp Concentrated Orange Juice - Effect of Temperature and Concentration. *Journal of Food Science*, 49(3), 882-888.

Wall, M. M. (2006). Ascorbic Acid, Vitamin A, and Mineral Composition of Banana (Musa sp.) and Papaya (Carica papaya) Cultivars Grown in Hawaii. *Journal of Food Composition and Analysis*, 19(5), 434-445.

Wang, L., and Sun, D. W. (2001). Rapid Cooling of Porous and Moisture Foods by using Vacuum Cooling Technology. *Trends in Food Science & Technology*, 12(5), 174-184.

Wardowski, W., Soule, J., Grierson, W., and Westbrook, G. (1979). Florida Citrus Quality Test. University of Florida, USA. Coop. Ext. Servo Bull, 188.

Wei, X. D., Zou, H. L., Chu, L. M., Liao, B., Ye, C. M., & Lan, C. Y. (2006). Field Released Transgenic Papaya Affects Microbial Communities and Enzyme Activities in Soil. *Plant and Soil*, 285(1-2), 347-358.

Whipkey, A., Simon, J. E. and Janick, J. (1999). 154 Indiana CropMAP and New Crop Compendium: New Developments from Purdue's Center for New Crops and Plant Products. *HortScience*, 34(3), 468-468.

White, D. T., Blackall, L. L., Scott, P. T., & Walsh, K. B. (1998). Phylogenetic Positions of Phytoplasmas Associated with Dieback, Yellow Crinkle and Mosaic Diseases of Papaya, and Their Proposed Inclusion in 'Candidatus Phytoplasma Australiense'and a New Taxon,'Candidatus Phytoplasma Australasia'. *International Journal of Systematic and Evolutionary Microbiology*, 48(3), 941-951.

Whitaker, J. R. (1993). Principles of Enzymology for the Food Sciences (Vol. 61). *CRC Press*. 120-123

Whitaker, J. R. (1996). Enzymes. In: Food Chemistry by Fenema, 489-492

Wiley, R. C. and Ooraikul, B. (1995). Minimally Processed Refrigerated Fruits and Vegetables. *Trends in Food Science and Technology*, 6(2), 67.

Williams, K. A. (2005). An overview of the US National Plant Germplasm System's Exploration Program. *HortScience*, 40(2), 297-301.

Wills, R. and Widjanarko, S. (1995). Changes in Physiology, Composition and Sensory Characteristics of Australian Papaya during Ripening. *Animal Production Science*, 35(8), 1173-1176.

Workneh, T. S., Azene, M., & Tesfay, S. Z. (2012). A Review on the Integrated Agro-Technology of Papaya Fruit. *African Journal of Biotechnology*, 11(85), 15098-15110.

Yahia, E., De Jesus, J. and Elansari, A. (2011). Postharvest Technologies to Maintain the Quality of Tropical and Subtropical Fruits. *Postharvest Biology and Technology of Tropical and Subtropical Fruits: Volume 1: Fundamental issues*, 142-193.

Yang, B.-m., Lin, D., Li, J. J., liu, f., Zhu, Z. Q. and Cheng, N. N. (2007). Studies on the Nutrition Characteristics of Banana. *Journal-Yunnan Agricultural University*, 22(1), 117.

Yousaf, M. S., Yusof, S., Manap, A., Bin, M. Y. and Abd-aziz, S. (2010). Storage Stability of Clarified Banana Juice Fortified with Inulin and Oligofructose. *Journal of Food Processing and Preservation*, 34(s2), 599-610.

Zhang, P., Whistler, R. L., BeMiller, J. N. and Hamaker, B. R. (2005). Banana Starch: Production, Physicochemical Properties, and Digestibility—A Review. *Carbohydrate Polymers*, 59(4), 443-458.

Zhuang, H., Barth, M. M. and Hildebrand, D. (2002). Fatty Acid Oxidation in Plant Tissues. *Food Science and Technology*-New York-Marcel Dekker-, 413-464.

Zipkes, M. R., Gilchrist, J. E. and Peeler, J. T. (1981). Comparison of Yeast and Mold Counts by Spiral, Pour, and Streak Plate Methods. *Journal-Association of Official Analytical Chemists*, 64(6), 1465-1469.

Zuhair, R. A., Aminah, A., Sahilah, A. M., & Eqbal, D. (2013). Antioxidant Activity and Physicochemical Properties Changes of Papaya (Carica papaya L. cv. Hong Kong) during Different Ripening Stage. *International Food Research Journal*, 20(4), 1653-1659.