THE EFFECT OF PACKAGING AND STORAGE PERIODS ON PHYSICOCHEMICAL OF *Moringa oleifera* LEAVES

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ABSTRACT

This study was conducted in Sekolah Pertanian Lestari (SPL) laboratory to evaluate the effect of packaging and storage periods on physicochemical characters of *Moringa oleifera* leaves. The mature leaves were freshly harvested and packed into two different packaging materials; Polyethylene (PE) and polypropylene (PP) bag and labelled as treatment 2 (T2) and treatment 3 (T3) respectively. Treatment 1 (T1) was a control, unpacked leaves. These treatments were stored inside cold room with temperature of 6±2°C. The parameters involved were weight loss, visual appearance, chlorophyll, carotenoid and ascorbic acid content. These parameters were evaluated for every four days interval until day 16 due to the end of storage period of the leaves as a result from pre-test for shelf life determination. Newly expanded leaves were chosen for parameter test. All data were analyzed by Two-way ANOVA and Tukey's test for mean comparison. The results showed that there was significant interaction between different treatments and storage periods on weight loss. No interaction between them on other parameters. T1 (51.62%) was the highest of weight loss compared to T2 and T3, while T3 (6.03%) had slightly reduction of weight loss during storage period. T1 showed change of colour of leaves obviously until day 4. After day 4, the colour score was significant lower than day 0 and 4. There was no significant different of treatments on chlorophyll content. Day 0 (5.29 µg $g^{-1}ml^{-1}$) resulted in higher significantly of mean chlorophyll content, carotenoid and ascorbic acid content. T2 (43.99 µg g^{-1}) and T3 (156.96 µg ml^{-1}) showed the highest mean of carotenoid and ascorbic acid respectively. The study concludes that PP bag was the best packaging material within the period of 4 days in preserving and maintaining quality of *M. oleifera* leaves.

KESAN PEMBUNGKUSAN DAN TEMPOH PENYIMPANAN TERHADAP FIZIKAL DAN KIMIA DAUN *Moringa oleifera*

ABSTRAK

Kajian ini telah dilakukan di makmal Sekolah Pertanian Lestari bagi mengkaji kesan pembungkusan dan tempoh penyimpanan terhadap ciri-ciri fizikal dan kimia daun *Moringa oleifera.* Daun yang matang dituai dan dibungkus dalam dua jenis pembungkusan yang berbeza, iaitu polietilena sebagai rawatan 2 (R2) dan polipropilena sebagai rawatan 3 (R3). Rawatan 1 (R1) merupakan kawalan yang mana tidak ada bahan pembungkus yang terlibat. Tiga rawatan ini telah disimpan di dalam bilik sejuk yang bersuhu $6\pm2^{o}C$. Parameter yang terlibat termasuklah jumlah kehilangan air, penampilan visual, kandungan klorofil, kandungan karotenoid dan kandungan asid askorbik. Setiap parameter telah dinilai pada setiap 4 hari dalam tempoh 16 hari penyimpanan daun tersebut. 16 hari merupakan tempoh masa penyimpanan berdasarkan dengan keputusan pra-ujian yang telah dilakukan. 'Newly expanded leaves' telah dipilih untuk diujikaji. Semua data telah dianalisis dengan menggunakan ANAVA dua hala dan ujian Tukey digunakan untuk perbandingan purata. Keputusan menunjukkan terdapat interaksi diantara rawatan yang berbeza dan tempoh masa penyimpanan terhadap kehilangan air dalam daun. R1 (51.62%) merupakan rawatan yang tertinggi dalam kehilangan air manakala R3 (6.03%) adalah rawatan yang mempunyai kehilangan air terendah sepanjang tempoh penyimpanan. R1 menunjukkan perubahan warna yang ketara pada hari ke-4. Tiada perbezaan beerti antara rawatan dengan kandungan klorofil tetapi ada perbezaan untuk tempoh penyimpanan. Hari 0 (5.29 $\mu g\ g^{-1}ml^{-1}$) mempunyai kandungan klorofil yang tertinggi. R2 (43.99 $\mu g\ g^{-1}$) mempunyai kandungan karotenoid tertinggi dan R3 (156.96 $\mu g\ ml^{-1}$) mempunyai kandungan askorbik asid yang tertinggi. Kesimpulannya, polipropilena adalah rawatan yang paling berkesan dalam tempoh 4 hari untuk mengekalkan kualiti pemakanan daun tersebut.

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^{o}C	Degree Celcius
%	Percent
µg	Micro gram
A	Absorbance
$A^{1\%cm}$	Absorption coefficient of caretone in PE (2592)
ANOVA	Analysis of Variance
cm	Centimetre
Chl	Chlorophyll
g	gram
HPO_3	Metaphosphoric acid
mg	Milligram
ml	Millilitre
MAP	Modified Atmosphere Packaging
MHC	Malaysian Herbal Corporation
MIGHT	Malaysian Indusrty-Government Group for High Technology
PE	Polyethylene
PE	Petroleum Ether
POPP	Perforated Oriented Polypropylene
PP	Polypropylene
RCBD	Randomize Complete Block Design
SPSS	Statistical Package for Social Science
SSA	School of Sustainable Agriculture
UMS	Universiti Malaysia Sabah
WHO	World Health Organization

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Moringa oleifera is the most widely cultivated herb species of the genus *Moringa*. It belongs to family Moringaceae and native to India. The most common names for *M. oleifera* are moringa, benzolive tree, kelor and murunggai. It is also known as drumstick tree because of the fruit's appearance which is long, slender, triangular seed pods and horseradish tree (Price, 1985). *M. oleifera* has potential in improving nutrition, boost food security, foster rural development and support sustainable land use. Not many people know about the existence of moringa as a herb because of its stem and it is not a shrub plant. The height of moringa may reach until 10 m (Radovich, 2011).

In Malaysia, herbs are very common and popular for their multipurpose especially as medicine. Many initiatives have been taken by the Malaysian government in order to promote the industrial development of herbs because of their high economic and pharmaceutical (Goblinmed, 2010). In the Third National Agricultural Policy, medicinal plants are chosen as one of commodities to lead Malaysia as the centre of raw materials for industrial uses.

According to the Malaysian Industry-Government Group for High Technology (MIGHT), the value of herbal related products in Malaysia is more than RM4.5 billion a year in 2005 and was expected to achieve a growth rate of 10 to 15% per annum. Nowadays, less than 10% of materials are used in the production of traditional medicines are cultivated locally.

The rest are either imported from overseas or collected from the wild. Malaysia is one of countries that is over dependent on imported product or raw materials which is leading to exposure of inconsistence supply, price instability and adulteration with low quality materials. It slows down the growth of the Malaysian herbal industry and will result in the outflow of foreign exchange.

Malaysian Herbal Corporation (MHC) is active in promoting the industry of herbs by organizing many activities such as consultancy services. People are assured about the importance of herbs nowadays. The statistic shows that there is the economic contribution drastically increased from year 1999 which is RM4.55 billion to RM 8 billion in year 2006, which is 10% increase per year (Efindi, 2009).

The World Health Organization (WHO) also reported that 80% of people in the world are using traditional medicines and number is increasing including teenagers. Herbal medicines are very popular and profitable in the international market (WHO, 2008). Malaysia's rain forest is known as tropical rain forest which is 19 million hectare approximately. Malaysia is reported as 2,000 types of medicinal plants or herbs. In Sabah, there is 1,250 species of plants that have been identified including their scientific names and medicinal values. Statistic shows that the total of import value for medicinal plants and aromatic plants increased from RM141 million in the year 1985 to RM431 million in the years 1996. This increasing amount automatically increases quantity of the healthy food which is 15% per annum.

Sabah has a rich biodiversity which provides a huge potential for the herbs, spices and aromatic industry because herbs have huge international market. Deputy Chief Minister of Sabah, Datuk Yahya Hussin said that herbs can also be cultivated by small farmers and poor people in rural area besides using herbs for market in a big scale. He also said, "*M. oleifera* is a crop categorized as herbs with many uses and products plus highly profitable international market, especially for the oil produced from the fruits. Indian usually use the fruit of *M. oleifera* in curry dishes. The leaves are highly nutritious which is used for tea." (Online Utusan, 2010).

M. oleifera is a highly valued plant that is mostly cultivated in the tropics and subtropics. It is used for food, medicinal and industrial purposes. The leaves have been used to combat malnutrition, especially among infants and nursing mothers (Price, 1985).

The nutritional content of Moringa leaves compares very well to common foods such as Vitamin A, Vitamin C, Calcium, Potassium, Protein, and B vitamin. In order to preserve and maintain the quality of the leaves, postharvest storage and packaging are very important. Packaging treatment could also increase the shelf life of Moringa leaves.

The leaves are not for human consumption only but also for animal productivity as it has nutritional, therapeutic and prophylactic properties. When an animal is exposed to pathogen, antibodies need to be raised to fight the infection. To gain immunity, the animal needs energy, proteins and vitamins in animal's body in order to fight the infection (Radovich, 2011).

Post harvest handling of herbs is another important aspect in production of raw materials for the commercial traditional medicines producers. Fresh horticultural produce is highly perishable with some estimates suggesting a postharvest loss of between 30-50% in fruits and vegetables especially in Asia. The losses in leafy vegetables are very high in the hot-wet season when compared to root or tuberous crops. The losses are due to poor pre-production and postharvest management as well as lack of appropriate processing and marketing facilities and breakdown in the distribution system. The problems of postharvest technologies are more critical in developing tropical countries than in the case of temperate countries. This is because of poor infrastructural facilities, transportation bottleneck and high temperature. The investment in research and in establishing proper infrastructural facilities and its optimum use has paid rich dividends in many countries. The trade in perishable vegetables has now been very much globalised. This has been made possible mainly because of the many technological innovations that had been developed in storage, transport, and postharvest technology.

There are many aspects of postharvest handling operations that need to be looked into in future research. Some of them are pre-cooling of produce, modified and controlled atmosphere packaging, improves packaging for distribution and refrigerator transport. The other problem is mostly Asian countries give priority of these programs to fresh fruits rather than vegetables.

1.2 Justification

This study is about initiatives to maintain the quality of *M. oleifera,* a plant with high nutritional value that not many people know about. There is less awareness about the importance of *M. oleifera* as herbs to people for health. There are many facts that show *M. oleifera* to be a beneficial plant in which almost all parts can be eaten (Radovich, 2011). *M. oleifera* can be commercially used as staple food to cure diseases especially for malnutrition.

Malnutrition has become a very serious problem in the world. With high value of vitamin A in *M. oleifera*, it can help reduce malnutrition problems in the world. Besides, many studies have shown that the leaves contain many protein, vitamin C, iron and calcium, compared to other green vegetables and they can be used for many purposes such as fodder, medicine and human consumption. This study concerns itself more on the effect of storage to shelf life of *M. oleifera* leaves.

In order to preserve the quality of post-harvest *M. oleifera* leaves, good storage with suitable temperature (cold) is needed to maintain the physicochemical characteristics of the leaves. Plastic material were chose as the treatments for packaging of *M. oleifera* leaves because it is cheaper, easy to handle and capable to extend shelf life based on previous studies. Moreover, it is affordable and farmers, retailers and distributers nowadays apply this method to avoid mechanical injury, inhibit pathogen growth and prolong shelf life.

1.3 Objective

The objectives of this study are:

1. To determine the effect of packaging on physicochemical characters of *Moringa oleifera* leaves.
2. To determine the effect of storage periods on physicochemical characters of *Moringa oleifera* leaves.

1.4 Hypothesis

Hypothesis for this study are:

a) H_0: There are no significant effects of packaging treatment in physicochemical characters of *Moringa oleifera* leaves

H_1: There are significant effects of packaging treatment in physicochemical characters of *Moringa oleifera* leaves

b) H_o: There are no significant effects of storage periods in physicochemical characters of *Moringa oleifera* leaves

H_1: There are significant effects of storage periods in physicochemical characters of *Moringa oleifera* leaves

CHAPTER 2

LITERATURE REVIEW

2.1 Botanical description of *Moringa oleifera*

Moringa oleifera belongs to family Moringaceae. *M. oleifera* is native to India (Figure 2.1 in Appendix A) and growing widely in tropics and subtropics. *M. oleifera* is a tree with freely branches and extremely fast growing. It can reach heights in excess of 10 m or 33 ft but usually the tree size is small to medium. The leaves are tripinnate compound with green to dark green elliptical leaflets 1-2 cm long. The flowers are borne on inflorescences with size of 10-25 cm long and generally white to cream colored, although sometimes they can be pink for other varieties. (Radovich, 2011).

The fruit is a tri-lobed capsule or called a pod. Immature pods are green and in some varieties have some reddish color. Pods are brown and dry at maturity which is contain 15-20 seeds. Seeds are large with three papery wings. Seed hulls are generally brown to black, but can be white if kernels are of low viability. The viable seeds will germinate within 2 weeks. Almost all parts of the *M. oleifera* tree are used for food, oil, fiber and medicine.

Pods and leaves are the most important parts in the Pacific. Young pods are consumed as vegetable. The very young pods are fibreless. This is because the weight is low for very young pods, including the commercially produced and more fibrous pods are used in soups, stews and curries. The nutritious leaves are eaten in many dishes including soups, stew and stir fries. The demand for human consumption of pods and leaves can be generally met by one or two backyard trees (Radovich, 2011).

The seeds can be roasted and eaten as peanut. Studies show that the seeds act as flocculent to clarify water and as a source of non-drying and very stable oil. The coagulants are used in water treatment processes for turbidity removal and classified into natural, inorganic and synthetic organic polymer. The coagulants are biodegradable and cause no harm to human. So, seeds from *M. oleifera* have been identified to be one of effective primary coagulants for water treatment (Katayon *et al.*, 2006). Besides, the seeds produce oil. The oil is clear, sweet and odourless (Anwar *et al.*, 2006). It is an edible oil and can be used in the cosmetic industry. The many uses and benefits of this plant are listed in Table 2.1 below.

Table 2.1: Uses and benefits of *M. oleifera* parts

Tree Parts	Uses and benefits
Leaves	Nutritional, forage, biomass, plant growth hormone, medicinal
Flowers	Nutritional, medicinal, honey
Fruits	Nutritional, medicinal
Roots	Medicinal
Seeds	Cosmetics, food, water treatment, medicinal
Wood	Paper, alcohol production, animal feed, medicinal
Bark	Rope making, gum for tanning hides, medicinal

Source: Noamesi *et al.*, 2006

2.2 Nutritional Values of *Moringa oleifera* Leaves

M. oleifera leaves contain high protein content which is 20-35% on a dry weight basis. The protein content has all the essential amino acid on it. *M. oleifera* is reported to have high quality protein which is easily digested and that is influenced by the quality of its amino acids (Foidl *et al.*, 2001). According to Foidl and and Paull (2008), *M. oleifera* leaves rich of nutrients such as vitamin A, vitamin C, calcium and potassium. The other study proved that the leaves are high in beta carotene and vitamin C when in raw. The beta carotene will be converted to vitamin A in human body. Usually the leaves are used as herbs because of their high value of antioxidants and they can be eaten when in raw to gain the benefits of vitamin C. Boiling also enhanced antioxidant activity of moringa leaves.

Price (1985) stated that nutrient content was higher in mature than young leaves, though people usually prefer to eat young shoots. Vitamin A was highest during the hot-wet season, whereas iron and vitamin C were highest during the cool-dry season. The leaves are the highest sources of minerals and vitamin B1. The leaves contain low phosphorus, fat and carbohydrate but high value of calcium and protein (Price, 1985).

The iron content is higher in the leaves due to report from Philippines about prescribed for anemia. There is three times more bio-available iron in boiled *M. oleifera* leaves than in raw materials. Besides that, the leaves contain high dry matter production around 20-25% compared to other plants that contain 10% dry matter. Research showed that 100 g of fresh leaves will bring twice as much nutritive material as 100 g of most other vegetables (Naomesi *et al.*, 2006).

Nutritional deficiencies can be reduced by consuming *M. oleifera* leaves as vegetables and herbs for pregnant woman and breast-feeding process. Pregnancy and breast-feeding need high content of iron and calcium to avoid risk of any deficiencies.

Breastfeeding women are suggested to take 400 to 1,000 µg of vitamin A for daily supplement. Therefore, 100 grams of fresh *M. oleifera* leaves could theoretically cover 100% of daily needs, but this is depending on storage conditions and how they are eaten, without exposed to light or heat (Naomesi *et al.*, 2006). According to Mustapha and Babura (2009), carotenoid content inside the Moringa leaves are higher than other vegetables such as carrots.

To gain high nutrient retention, it is advised to consume fresh leaves for a short time or eat them in raw since *M. oleifera* is called as herbs. Fuglie (2005) states that 8 g serving of dried leaf powder will satisfy a child of 1-3 years with 14 % of the protein, 40 % of the calcium, 23 % of the iron and nearly all the vitamin A that the child needs in a day. As little as 20 grams of dried leaves would provide a child with all the vitamins A and C he needs. It is fast growing and drought resistant, remaining green when other leafy vegetables are out of season. This makes it available all year round as a supplement to the diet.

Table 2.2: Nutritional values of *M. oleifera* leaves in different forms

Nutritional analysis	Pods (per 100 grams)	Fresh raw leaves (per 100 grams)	Dried leaf powder (per 100 grams)
Moisture (%)	86.9	75	7.5
Calories	26.0	92.0	205.0
Protein (g)	2.5	6.7	27.1
Fat (g)	0.1	1.7	2.3
Carbohydrate (g)	3.7	13.4	38.2
Fiber (g)	4.8	0.9	19.2
Mineral (g)	2.0	2.3	
Calcium (mg)	30.0	440.0	2003.0
Magnesium (mg)	24.0	24.0	368.0
Phosphorous (mg)	110.0	70.0	204.0
Potassium (mg)	259.0	259.0	1324.0
Copper (mg)	3.1	1.1	0.6
Iron (mg)	5.3	0.7	28.2
Oxalic acid (mg)	10.0	101.0	0.0
Sulphur	137	137	870
Vitamin A – Beta carotene (mg)	0.1	6.8	16.3
Vitamin C – ascorbic acid (mg)	120	220	17.3

Source: Dolcas Biotech, 2006

2.3 The Importance of Postharvest Handling

Appropriate production practices, careful harvesting and proper packaging, storage and transport are contributing to produce good quality of vegetables. Production practices have a tremendous effect on the quality of fruits and vegetables at harvest and on postharvest quality and shelf life. Firstly, it is well known that some cultivars ship better and have a longer shelf life than others. In addition, environmental factors such as soil type, temperature, frost, and rainy weather at harvest affected the storage life and quality. For example, carrots grown on muck soils do not hold up as well in storage as carrots grown on lighter, upland soils. Lettuce harvested during a period of rain does not ship well and product losses are increased (Herner and Robert, 1989).

Quality cannot be improved after harvest, it can only be maintained. Therefore it is important to harvest fruits, vegetables, and flowers at the physiological maturity with suitable size and quality. Immature or over mature produce may not last as long in storage as that picked at proper maturity (Wilson *et al.*, 1995).

Harvest should be completed during the coolest time of the day, which is usually in the early morning, and produce should be kept shaded in the field. Handle produce gently. Crops destined for storage should be as free as possible from skin breaks, bruises, spots, rots, decay, and other deterioration. Bruises and other mechanical damage not only affect appearance, but provide entrance to decay organisms as well.

For postharvest and storage, there are many things need to be considered such as packaging and temperature. Packaging should be designed to prevent physical damage and be easy to handle. There are many types of packaging nowadays such as polyethylene (PE) bags, modified atmosphere packaging (MAP) and polypropylene (PP) bags.

Temperature is the single most important factor in maintaining quality after harvest. Refrigerator storage reduces aging, undesirable metabolic changes and respiratory heat production, moisture loss, spoilage due to invasion of bacteria and undesirable growth. The stage of development at which a product is regarded as mature depends on its final use. There are no general rules when it comes to defining horticultural maturity.

A lot of research has been done to establish maturity parameters for a whole range of specific horticultural products. Maturity must be defined for each product in some cases for each variety of a particular product. The use of maturity standards provides consumers with a minimum level of quality assurance. Another reason for establishing maturity standards is that most horticultural products are harvested by hand. A simple color guide and size can help pickers harvest produce at the correct stage of development.

2.4 Packaging material of leafy vegetables

Packaging is purposely made to reduce loss of quality, deterioration by pathogen, mechanical damages from harvesting, transportation and storage. Packaging also plays main role in prolonging product's shelf life besides maintain the quality and its marketable life. Many plastic bags are cheap such as PE, which is providing modified atmosphere for any product. There are many alternatives to pack vegetables using many types of packaging materials and it is considered as high technology in order to minimize the post harvest losses.

2.4.1 Packaging for fresh fruits and vegetables

Fresh vegetables are living organisms which the physiological and biochemical activities are continuous even after harvest. Fresh vegetables contain 80 to 90% of moisture content. They will dry rapidly with normal atmospheric condition if there is no any treatment applied to them and the dry happened because of transpiration process. Transpiration is releasing water from plants through leaves. Almost 90% of water that enter the plants is used for this process. The other 10% is for photosynthesis and cell growth. Transpiration rates are influenced by weather condition such as temperature, humidity, sunlight, light intensity, precipitation, soil type and saturation, wind and water. When the moisture loss is high, commodity deterioration will be occurred including microbes infection and shorten shelf life (Das and Bhardwaj, 2012).

In order to minimize losses of water due to transpiration, the vegetables should be stored in low temperature and high humidity place. This is to longer the shelf life and maintains the market quality of the vegetables. The proper storage condition may help reducing transpiration (Ben-Yehoshua, 1969). Respiration process is also involved and related with transpiration process. Respiration is chemical process by which fruits and vegetables convert sugar into carbon dioxide, heat and water. The heat produce may deteriorate vegetables and fruits. The water vapor pressure is increases as well as the transpiration process.

The materials that involved in packaging of fresh fruits and vegetables are bamboo, wood, gunny bags, plastic films, fiber and corrugated boards. Bamboo basket is low and not strong enough to withstand rough handling. Woods cannot be reused because they are heavy and difficult to bring. Cushioning materials also being used to store vegetables and fruits such as dry grasses, paddy straw, leaves, saw dust, paper shreds and so on. They are very useful, resilient property, free from infection and heat of respiration is released and disappears. For example, Cassia leaves are effective in maintaining the quality.

Plastic is one of the best packaging of almost all vegetables and fruits because these products are perishable. This is because it reduces cost of packaging material and less dependent on limited sources such as wood (FAO, 2002). Mango is packed in plastic bag to reduce bruising during transportation. There are many types of plastic for packaging usage; polypropylene (PP), polystyrene (PS), polyethylene (PE) and PVC. Polypropylene (PP) has good properties and it can be reused for a few times. The example of polypropylene usage is on apple for maintaining its quality while in long distance transportation. PP is also harder and has higher softening point than PE. Polystyrene (PS) is rigid, brittle, transparent plastic. It is same as PE and PP. Three of them have transparent type. PS is fairly permeable to gases. And high water vapor transmission rate (FAO, 2002).

REFERENCES

Albrecht, J. A., Schafer, H. W. and Zottola, E. A. 1991. Sulfhydryl and Ascorbic Acid Relationship in Selected Vegetables and Fruits. *Food Science* **56 (2)**: 427

Anonymous. 2006. *Moringa oleifera.* Dolcas Biotect LLC. http://moringamalunggay.com/moringa-fresh-leaf-vs-dried-leaf.pdf. Access on 10 November 2012. Verified on 11 December 2012.

Anonymous. 2010. Production Technology of Herbs. Global Information Hub on Integrated Medicine. http://www.globinmed.com/index.php?option=com_content&view=article&id=79421:production-technology-of-herbs&catid=814:others. Access on 12 April 2012. Verified on 20 April 2012

Anwar, F., Zafar, S. N. and Rashid, U. 2006. Characterization of *Moringa oleifera* Seed Oil from Drought and Irrigated Regions of Punjab, Pakistan. *Grasas Y Aceites* **57**:160-168

Association of Official Analytical Chemists. 1980. Official Methods of Analysis. 734-740

Babarinde, G. O and Fabunmi, O. A. 2009. Effects of Packaging Materials and Storage Temperature on Quality of Fresh Okra (*Abelmoschus esculentus*) Fruit. *Agricultural Tropical and Subtropical* **42 (4)**

Batu, A. and Thompson, A. K. 1998. Effect of Modified Atmosphere Packaging on Post-harvest Qualities of Pink Tomatoes. *Journal of Agriculture and Forest* **22**: 365-372

Ben-Yehoshua, S. 1969. Gas Exchange, Transpiration, and the Commercial Deterioration in

Bhardwaj, A. and Choudhuri, S. 2012. *Molecular Biology and Physiology.* New Delhi: Wisdom Press

Bhowmik, S. R. and Pan, J. C. 1992. Shelf Life of Mature Green Tomatoes Stored in Controlled Atmosphere and High Humidity. *Journal Food Science* **57(4)**: 948-953

Chau, K. and Talasila, P. 1994. Design of Modified Atmosphere Packages for Fresh Fruits and Vegetables. In: Minimal Processing of Foods and Process Optimization. Boca Raton, USA. 407-416

Das, S. M. and Bhardwaj, A. 2012. *Plant Physiology.* New Delhi: Wisdom Press

Efindi, B. 2009. Nilai Pasaran Herba RM8b. *Harian Metro*, 9 April

FAO. 2002. Handling and Processing of Organic Fruits and Vegetables in Developing Countries

Favell, D.J. 1998. A Comparison of the Vitamin C Content of Fresh and Frozen Vegetables. *Food Chemistry* **62**: 59-64

Ferrante, A., Incrocci, L., Maggini, R., Serra, G. and Tognoni, F. 2004. Colour Changes of Fresh-cut Leafy Vegetables During Storage. *Journal Food Agricultural Environment* **2**: 40-44

Foidl, N., and Paull, R. 2008. *Moringa oleifera.* In: The Encyclopedia of Fruit and Nuts. CABI, Oxfordshire, UK. 509–512

Foidl, N., Harinder, P. S. and Becker, K. 2001. Potentiel du Moringa oleifera pour les besoins agricoles et industriels in L'arbre de la vie, Les multiples usages du Moringa. CTA et CWS, Dakar. 45-78.

Fuglie, L. J. 2005. The Moringa Tree: A Local Solution to Malnutrition? Church World Service in Senegal

Gaffney, J. J., Baird, C. D. and Chau, K. V. 1985. Influence of Air Flow Rate, Respiration, Evaporation Cooling, and Other Factors Affecting Weight Loss Calculation for Fruits and Vegetables. *ASHRAE Transaction* **91(1B)**: 690-707

Gareth, L. O., Gisela and Rui. M. 1998. Productions of a Carotenoid-rich Product by Alginate Entrapment and Fluid-bed Drying of *Dunaliella salina. Journal of Science Food Agriculture* **76**: 298-302

Gil, M. I., Ferreres, F., & Tomás-Barberán, F. A. (1998). Effect of modified atmosphere packaging on the flavonoids and vitamin C content of minimally processed Swiss Chard (Beta vulgaris Subspecies cycla). *Journal of Agricultural and Food Chemistry* **46**: 2007-2012

Gosbee, M. and Marte, S. 2000. Optimizing Storage Conditions for Selected Asian Vegetables. Horticulture Technical Report.

Herner and Robert, C. 1989. Sources of loss cited during post harvest handling. *Great Lakes Vegetable Growers News*

Hong, S. and Kim, D. 2004. The Effect of Packaging Treatment on the Storage Quality of Minimally Processed bunched onions. *International Journal of Food Science and Technology* **39**: 1033–1041

Howard, L.A., Wong, A.D., Perry, A.K and Klein, B.P. 1999. B-carotene and Ascorbic Acid Retention in Fresh and Processed Vegetables. *Journal Food Science* **64**: 929-934

Kader, A.A., Zagory, D. and Kerbel, E.L. 1989. Modified Atmosphere Packaging of Fruits and Vegetables. *Critical Reviews in Food Science and Nutrition* **28**: 1–30

Katayon, S., Ng, S. C., Johari, M. M. N. M. Abdul, G. L. A. 2006. Preservation of Coagulation Efficiency of *Moringa oleifera*, a Natural Coagulant. *Biotechnology and Bioprocess Engineering* **11**: 489-495

Krause, G. and Weis, E. 1988. The photosynthetic apparatus and chlorophyll fluorescence: An introduction. In: H. K. Lichtenhaler (Ed.). *Application of chlorophyll fluorescence in photosynthesis research, stress physiology, hydrobiology and remote sensing* Dordrecht, Netherlands. 3–11

Lu, S. 2005. Effect of Packaging on Shelf-life of Minimally Processed Bok Choy. *Society of Food Science and technology* **40**: 460- 464

M. Ufuk, K. and Rezzan, K. 2012. Color Changes of Fresh-cut Swiss Chard Leaves Stored at Different Light Intensity. *American Journal of Food Technology* **7**: 13-21

Martinez, Y., Diaz, L. and Manzano, J. 2003. Influences of Nitrogen and Potassium Fertilizer on the Quality of "Jupiter" Pepper (*Capsicum annuum*) under Storage. *Acta Horticulture* **628**: 135-140

Martinez-Sanchez, A., Allende, A., Bennett, R.N., Ferreres, F. and Gil, M.I. 2006. Microbial, Nutritional and Sensory Quality of Rocket Leaves as Affected by Different Sanitizers. *Postharvest Biology and Technology* **42**: 86-97

Moreira, M. R., Roura, S., & Del Valle, C. E. (2003). Quality of Swiss Chard Produced by Conventional and Organicmethods. *Food Science and Technology* **36**: 135-141

Muchoki, C.N., Imungi, J.K. and Lamuka, P.O. 2007. Changes in Beta Carotene Ascorbic Acid and Sensory Properties in Fermented, Solar-Dried and Stored Cowpea Leaf Vegetables. *African Journal of Food Agriculture and Nutrition and Development* **7 (3)**

Negi, P.S. and Roy, S.K. 2001. Effect of Drying Conditions on Quality of Green Leaves During Long Term Storage. *Food Research International.* **34 (2001):** 283- 287

Ngure, J. W., Aguyoh, J. N. and Liu, G. 2009. Interactive Effects of Packaging and Storage Temperatures on the Shelf-Life of Okra. *ARPN Journal of Agricultural and Biological Science* **4 (3)**

Niyomloa, W., Kanlayanarat, S. and Maneerat, C. 2000. The Effect of Hydro-cooling and Plastic Bag Packaging on the Shelf Life of Chinese Kale. In: ACIAR Proceedings. Thailand

Noamesi, S., Amaglo, N., Adevu, M., Amengor, M.G., Dosu, G., Adjepong, P., Adam, S. and Attipoe, P. 2006. Growing and Processing Moringa leaves. Ghana: Moringa Association of Ghana

Okeibuno-Badifu, G. I. 1991. Effect of Long-term Storage of Processed Nigeria-grown Edible Leafy Green Vegetables on Vitamin C Content. *Journal of Agriculture Food Chemistry* **3**: 538-541

Okolie, N. P. and Sanni, T. E. 2012. Effect of Post Harvest Treatments on Quality of Whle Tomatoes. *African Journal of Food Science* **6 (3)**: 70-76

Onayemi, O. and Okeibuno Badifu, G.I. 1987. Effect of Blanching and Drying Methods on Nutritional and Sensory Quality of Leafy Vegetables. *Plant Foods for Human Nutrition* **37**: 291-298

Online Utusan. 2010. Ambil Peluang Menceburi Industri Herba. *Utusan Online*, 1 December

Piagentini, A. M., Mendez, J. C., Guemes, D. R. and Pirovanni, M. E. 2005. Modelling Changes of Sensory Attributes for Individual and Mixed Fresh-CutLeafy Vegetables. *Postharvest Biology and Technology* **38**: 202-212

Porra, R.J., Thompson, W.A & Kriedemann, P.E. 1989. Determination of Accurate Extinction Coefficients and Simultaneous Equations for Assaying Chlorophylls a and b Extracted with Four Different Solvents: Verification of the Concentration of Chlorophyll Standards by Atomic Absorption Spectroscopy. **975**: 384-394

Prabhu, S. and Barett, D.M. 2009. Effects of Storage Condition and Domestic Cooking on the Quality and Nutrient Content of African Leafy Vegetables. *Society of Chemical Industry* **89**: 1709- 1721

Price, M. L. (2007). *The Moringa Tree.* United States: ECHO.

Radovich, T. (2011). *Farm and Forestry Production and Marketing profile for Moringa.* United States: Permanent Agriculture Resources

Ranggana, S. 1986. Handbook of Analysis and Quality Control for Fruits and Vegetables Product. New Delhi: Tata McGraw Hill Publication Co. Ltd. 112

Rivera, J.R.E., Stone, M.B., Stushnoff, C., Pilon-Smits, E. and Kendall, P.A. 2006. Effects of Ascorbic Acid applied by Two Hydrocooling Methods on Physical and Chemical Properties of Green Leaf Lettuce Stored at 5°C. *Journal Food Science* **71**: 270-276

Roura, S., Davidoch, L., and Del Valle, C. 2000. Postharvest Changes in Fresh Swiss Chard under Different Storage Conditions. *Journal of Food Quality* **23**: 143-147

Roura, S.T., L.A. Davidovich and C.E. Valle, 2000. Quality loss in minimally processed Swiss chard related to amount of damaged area. *Lebensmittel Wissenscaft Technology* **33**: 53-59

Sakaldas, M., Ashm, A. S., Kuzucu, C. O. and Kaynas, K. 2010. The Effect of Modified Atmosphere Packaging and Storage Temperature on Quality and Biochemical Properties of Dill (*Anethum graveolens*) Leaves. *Journal of Food, Agriculture and Environment* **8**: 21-25

Santi, R., Bhowmilk, S. R. and Jung, C. P. 1992. Shelf Life of Mature Green Tomatoes Stored in Controlled Atmosphere and High Humidity. *Journal Food Science* **57**: 948-951

Singh, S. K. and Srivastava, S. 2009. *Plant Physiology and Biochemistry*. New Delhi: Campus Books International

Singh, U. and Sagar, V. R. 2010. Quality Characteristics of Dehydrated Leafy Vegetables Influenced by Packaging Materials and Storage Temperature. *Journal of Scientific and Industrial Research* **69**: 785-789

Souzan, S.L. and Abd El-Aal, H.A. 2007. Mineral Profile- Shelf Life Extension and Nutritive Value of Fresh Green Leafy Vegetables Consumed in Egypt. *African Crop Science Society* **8**: 1817-1826

Storage of Orange Fruit. *Journal of the American Society for Horticultural Science* **94(5)**: 524-528

Tasdelen, O. and Bayindirli, L .1998. Controlled Atmosphere Storage and Edible Coating Effects on Storage Life and Quality of Tomatoes. *Journal Food Processing Preservation* **22**: 303-320

Toivonen, P. M. A. 1997. The effects of storage temperature, storage duration, hydro-cooling and micro-perforated wrap on life of broccoli (*Brassica oleracea* L. Italica Group.) *Posthavest Biology and Technology* **10**:59–65

Toivonen, P.M.A. 1997. The effects of storage temperature, storage duration, hydro-cooling and micro-perforated wrap on life of broccoli (*Brassica oleracea* L. Italica Group.) *Posthavest Biology and Technology* **10**: 59–65.

Toledo, M.E.A., Ueda, Y. and Shirosaki, T. 2003. Changes of Ascorbic Acid Contents in Various Market Forms of Spinach (*Spinacea oleracea* L.) during Postharvest Storage in Light and Dark Conditions. *Science Representative Graduan School Agriculture & Biology* **55**: 1-6

United States Pharmacopoeia. 1980. Mack Coorperation Easton PA. 55

Vina, S.Z. and Chaves, A.R. 2003. Textural Changes in Fresh Cut Celery during Refrigerated Storage. *Journal Science Food Agriculture* **83**: 1308- 1314

Wilson, L.G., M.D. Boyette, and E.A. Estes. 1995. Postharvest Handling and Cooling of Fresh Fruits, Vegetables and Flowers for Small Farms. Leaflets 800–804. North Carolina Cooperative Extension Service. http://www.foodsafety.org/nc/nc1055.htm. Accessed on 7 September 2012. Verified on 9 October 2012

Woo, P. K., Min K. H. and MI Y. E. 1999. Effects of Film Package and Storage Temperature on the Quality of Parsley in Modified Atmosphere Storage. *Acta Horticulture* **483**: 291-298.

Zagory, D. and Kader, A. A. 1988. Modified atmosphere packaging of fresh produce. *Food Technology* **42(9)**:70-77

Zenoozian, M. S. 2011. Combined Effect of Packaging Method and Temperature on the Leafy Vegetables Properties. *International Journal of Environmental Science and Development* **2(2)**

Zenoozian, M. S. 2011. Effect of Modified Atmosphere Packaging on Quality Changes of Fresh Parsley, Spinach and Dill. *International Journal of Environmental Science and Development* **6**