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**IIAZAH:** BACHELOR OF AGRICULTURE SCIENCE WITH HONOURS

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EFFECT OF CARBOHYRATE ON THE VASE LIFE OF POSTHARVEST CHRYSANTHENUM

YONG KAR YAN

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HORTICULTURE AND LANDSCAPING PROGRAMME
SCHOOL OF SUSTAINABLE AGRICULTURE
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2010
DECLARATION

I declare that no part of this dissertation has been previously submitted for a degree in this or any other universities. All the works were based on my own research except as cited in references and other part of the dissertation where indicated.

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This study was conducted to evaluate the effect of different concentrations of carbohydrate solutions on chrysanthemum and to determine the vase life of chrysanthemum after treatment of carbohydrate solutions. Chrysanthemum flowers that harvested from Ranau farm were treated with sucrose, fructose and glucose solutions in the concentrations of 5%, 10%, 15% and 20% under room temperatures (25 °C ± 5 °C). Chrysanthemum flowers that treated with distilled water were used as control in this study. The result showed that postharvest treatment of carbohydrate solutions significantly affected the water uptake and bud size of chrysanthemum flowers. The highest water uptake of flower samples was 15% fructose as the vase life of the flower samples also extended longer to 24 days. In this study, 15% fructose was the highest flower bud size compared to other three carbohydrate solutions. Treatment of carbohydrate solutions was effective in prolonging vase life of chrysanthemum flowers. Without the carbohydrate treatment, flower samples that treated with distilled water were wilt in the day of six. However, with supplement of carbohydrate solutions, vase life of chrysanthemum flowers extended more than six days. The highest extended vase life of chrysanthemum flowers was treated with 15% fructose which reached the day of 24. Extended of vase life in flower samples were different according to different concentrations in the three carbohydrate solutions. Low concentration of 5% in the three carbohydrate solutions was not effective in the supplying of nutrient for chrysanthemum flowers, while higher concentration of 20% in the three carbohydrate solutions was over supplying of nutrient to the flowers and resulted injury to the floral structure. The concentration of 15% of the three carbohydrate solutions was the most effective and suitable supplement for chrysanthemum. In this study, the results showed the most effective carbohydrate solution was 15% fructose as postharvest treatment for prolonging vase life of chrysanthemum flower.
PENGARUH KARBOHIDRATE TERHADAP HAYAT HIDUP BUNGA KEKWA LEPAS TUAI

ABSTRAK

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<th>Description</th>
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<tr>
<td>°F</td>
<td>Degree Fahrenheit</td>
</tr>
<tr>
<td>fc</td>
<td>Footcandle</td>
</tr>
<tr>
<td>μ mol</td>
<td>mikro mol</td>
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CHAPTER 1

INTRODUCTION

1.1 Importance of cut flower

Flowers are grown in covered greenhouses and outside in open fields. Any flower that is cut from the plant, any thorns are trimmed, and is ready to be used in fresh flower arrangement can be defined as cut flower. Cut flowers usually are supplied from the florist or can be cut from the home garden. Cut flowers are parts of plants. It included the parts of blooms or “inflorescences” and some attached plant materials, but not including roots and soil.

Fresh cut flowers can be maintained at a limited life-supporting after removed from the soil. They can uptake water through their stem. However, they are highly perishable. Fresh cut flowers are used for decorative purposes for example cut flowers truly importance to beautify the stage and surrounding areas during the convocation in universities such as vase arrangements and bouquets at formal events. Other than that, cut flowers are needed to design for weddings and funerals; as gifts on occasions such as Mother’s Day, Valentine’s Day, in times of illness, and during cultural events such as Christmas and Easter; informal displays to beautify homes and public places (Armitage and Laushman, 2003).
Cut flowers are usually sold in bunches or as bouquets with cut foliage. Production of cut flowers is specifically known as cut flower industry. Cut flower industry in Malaysia is still new and recent. It has turns into commercial enterprise from personal hobby. Lately, the growth and production of cut flowers increase and attract wide local and foreign demands. In third National Agriculture Policy (1992-2010) and Seventh, Eighth, Ninth of Malaysia Plans, cut flowers have been identified as one of the priority group of crops with good potential to meet growing domestic and international demand. A well cut flower industry can generate a higher income for the producers. This industry in Malaysia is very bright due to the growth in domestic and export markets.

So, it is important to increase the fields with greater consumer affluence, growing appreciation for fresh cut flowers and improve the postharvest handling. Increasing demand for cut flowers in international market is expected to continue at a growth rate of 6 percentages per annum. According to the Plant Quarantine Section Revenue of Sabah Agricultural Department, result in the increasing demand from local and international demand of cut flowers, it is expected that income trade from cut flower industry will be reach RM 36 billion in the year of 2010.

One of the popular cut flowers productions in Malaysia is chrysanthemum. There are several types of chrysanthemum. Standard chrysanthemums have one flower per stem with stems range from 18 to 36 inches. It also included the diameter of each bloom ranging from 3 to 8 inches. Pompon chrysanthemums have four to 6 flowers per stem with stem range from 18 to 30 inches and diameter of 3 to 5 inches. Depending on the variety and temperature, pompon chrysanthemums can last more than 9 days and standard chrysanthemums can last more than 7 days (Armitage and Laushman, 2003).
Chrysanthemums were cultivated in China as a flowering herb as far back as the 15th century BC. The flower was introduced into Japan probably in the 8th century AD, and the Emperor adopted the flower as his official seal (Harborne et al., 1970; Hutchinson et al., 1992; Khallouki et al., 2000; Teixeira da Silva, 2003).

There is a “Festival of Happiness” in Japan that celebrates the flower. For Asian people, this flower is very important to them in their living life. People usually use the flower for special ceremonies such as ‘Qing Ming’ and also as offering to God in temples. Local people also like to use it for decoration in marriage ceremony.

Chrysanthemums are popular perennial flowers. They offer a wide variety of flower colors, from white and cream to dark maroon and burgundy, as well as numerous growth habits from small dwarf plants to giant shrub-like mums. Chrysanthemums are easy to grow and can provide years of enjoyment if care is taken to select an appropriate variety; plant in a sunny, well drained, location; and provide winter protection.

In Malaysia, chrysanthemums are often cultivated in highlands. Only after reaching flowering size, they will be transported down to the lowlands for sale. Besides, chrysanthemum sp. is important floricultural and ornamental crops. It is type of plant with function of culinary, medicinal and (ethno)-pharmacological interest (Teixeira da Silva, 2003). It is also important in educational purposes in teaching flower arrangement (Teixeira da Silva, 2003). Chrysanthemum sp. is a source of various valuable secondary metabolites; it contains biologically active compounds and essential oils (Schwinn et al., 1994; Teixeira da Silva, 2003).
1.2 Problem of Flower Handling and Importance of Study

Table 1.1 showed the statistic of import quantities of several types of cut flowers from January to 30 June of 2009. Quantity of chrysanthemum sp. that needed to be imported into Malaysia is higher compared to rose plants, orchid plants, and vanilla cuttings. There is a low supply of chrysanthemum from local plantation. However, there is a high demand of chrysanthemum from local people. Studies also show that there is a limitation of post harvest cultivation conditions toward vase life of cut flowers such as chrysanthemum, gladiolus and lily (Pandya and Saxena, 2003). So, it is one of the main reasons that chrysanthemum will be chosen as study object in postharvest.

Table 1.1 Statistics of Imported Cut Flowers from 1st Jan to 30 June 2009

<table>
<thead>
<tr>
<th>Type of flowers</th>
<th>Number of flowers (stalks)</th>
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<tbody>
<tr>
<td>Fresh cut flower</td>
<td>790607</td>
</tr>
<tr>
<td>Chrysanthemum cuttings</td>
<td>142500</td>
</tr>
<tr>
<td>Fresh Pussy Willow Cuttings</td>
<td>42000</td>
</tr>
<tr>
<td>Vanilla cuttings</td>
<td>5000</td>
</tr>
<tr>
<td>Orchid plants</td>
<td>884</td>
</tr>
<tr>
<td>Rose plants</td>
<td>300</td>
</tr>
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Source: Jabatan Pertanian, Kota Kinabalu, 2009

There are several sub-problems that influence the market ability of chrysanthemum. This study is important to find out the most effective post harvest treatment toward chrysanthemum using carbohydrate solution. The problem of wilting that occurs among chrysanthemum after harvest can reduce the profit. However these flowers are cut and brought indoors, wilting will reduce their beauty and quality. When a flower starts to wilt, its vase life is shortened; consequently, its market value falls. So it is very important to have an effective treatment to prolong the vase life after the post harvest of this cut flower.

The main postharvest problems for chrysanthemums are premature foliage yellowing, wilting and the failure of the flowers to fully open. Yellow foliage is cultivar specific and is caused by poor production, excessive or improper storage and preservative solutions used at higher than recommended concentrations (Watkins et al.,
1995). Cut chrysanthemum of some cultivars placed in interior room can keep their fresh quality for 20 to 30 days (Prakash and Pierik, 1990), which senescence rapidly and wilt within several hours after the opening of their flowers.

This study is carried out to determine which group of carbohydrates (sucrose, glucose and fructose) is the most suitable treatment solution for prolonging the vase life of chrysanthemum (Pandya and Saxena, 2003). Sucrose, glucose and fructose were shown to support metabolic growth in chrysanthemum especially in cultivar ‘Lineker’ and ‘Shuhou-no-chikara’ (Teixeira da Silva, 2003). A main well known factor about supplying sugar is that it increases the longevity of many cut flowers (O’Donoghue et al., 2002). However, the basis of this improvement still not fully understood. There are several researches shown that sucrose supplementation is effective in several levels (O’Donoghue et al., 2002) but not clear in what level of concentration. The blockage and damage of xylem is the most reasonable point why flower wilt (Teixeira da Silva, 2003). After the process of harvest, the flower can’t receive any carbohydrate supply and water content from root system. Study on the supply of carbohydrate solution is to prolong the vase life of chrysanthemum. Under the control of temperature, three types of carbohydrate solutions will be used. A normal postharvest chrysanthemum will wilt after 3 to 4 days. A most suitable carbohydrate solution will improves petal color, increased bud opening, strengthened pedicels and prolong vase life of chrysanthemum up to nine days (Pandya and Saxena, 2003). Observation and determination of the most effective carbohydrate treatment for prolonging the vase life of chrysanthemum is needed.

1.3 Objectives

1. To evaluate the effect of different concentrations in different carbohydrates on chrysanthemum.

2. To determine the vase life of chrysanthemum after carbohydrate treatment.
2.1 Origin of Chrysanthemum

Chrysanthemum is one of the most important global cut flower and pot plants. Study shown that members of the chrysanthemum-complex include important floricultural (cut-flower) and ornamental (pot and garden) crops, as well as plants of culinary, medicinal and (ethno)-pharmacological interest (Teixeira da Silva, 2003).

Some division surrounds the exact nomenclature of chrysanthemum, for example Chrysanthemum sensu stricto being C. carinatum, C. coronarium and C. segetum. Chrysanthemum is a group that still includes Achillea, Ajania, Anthemis, Arctanthemum, Argyanthemum, Artemisia, Balsamita, Chrysanthemum, Dendranthema, Heteranthemis, Hymenostemma, Ismelia, Leucanthemella, Leucanthemum, Matricaria, Nipponanthemum, Pyrethrum, Tagetes, Tanacetum and Tripleuspermum, sometimes collectively termed the Chrysanthemum-complex (Teixeira da Silva, 2003).

Plant taxonomy now classifies chrysanthemums under the genus, Chrysanthemum. Other common names for chrysanthemums are based on the shortened version which is ‘mums’ of genus name. The genus once included many species, but was split several decades ago into several genera; this statement was ruled by the International Code of Botanical Nomenclature in the year of 1999. During the period between the splitting of
the genus and the International Code of Botanical Nomenclature ruling, chrysanthemums commonly treated under the genus name *Dendranthema* (Teixeira da Silva, 2003).

Chrysanthemum hybrids originated from China and have been cultivated for more than 1200 years in Japan and more than 1400 years in China. Garden chrysanthemums were grown in Europe in the 18th century. Over centuries, scientists and researchers have developed thousands of the cultivars around the world. Cultivars exist that are suited to specific growing areas around the world such as northern, central, or southern Europe; North America; Israel; South America; or sections of Africa.

Every year, there are new cultivars released for cut flower, potted flowering plant, or garden use. However, numerous cultivars have been lost or discarded that were fragile and difficulty in transportation of flower production around the world. Modern chrysanthemum cultivars come in with astonishing variety of colors (white, yellow, red, bronze and pink), color combinations and petal styles (spoon, quill, and flat).

The central disc florets may be numerous or have only one or two rows. For daisy types, consumers prefer the central disc florets be yellow, while growers and wholesalers favor green centers. Cultivars for chrysanthemum production can also group by height and vigor: tall, medium and short. Tall varieties flowers naturally on vigorous stems more than 15 inches (38 cm) long after the start of short day length (SD) chrysanthemum. Medium varieties of chrysanthemum naturally flower on stems no longer than 15 inches (38 cm). Short varieties naturally flower on stems under 15 inches (38 cm). The rates and frequency of growth retardant applications is determined by the height classification of a cultivar of chrysanthemum (Cockshull, 1985).
Photo 2.1 *Chrysanthemum indicum* (yellow variety)

Photo 2.2 *Chrysanthemum indicum* in bud stage
2.2 Biology of Chrysanthemum

2.2.1 Propagation of Chrysanthemum

In chrysanthemum production, cuttings of chrysanthemum are very important. Commercially, cuttings are produced by specialty propagators who maintain pathogen-free stock plants. A successful cutting is not easy to produce. Cuttings of chrysanthemum are produced in only a few locations around the world and are efficiently distributed by air to growers. Terminal cuttings 2.5 to 3 inches (6.5 to 7.5 cm) long are sold either rooted or unrooted.

Cuttings root with ease in one to two weeks under mist, fog, or plastic lay directly over the cuttings. Growers usually will provide rooting hormone onto the base of the cuttings to speed rooting. Rooted cuttings of chrysanthemum are directly planted in pots or beds and kept fogged or misted for several days until established. Light intensity of 67 fc (10 μmol m⁻² s⁻¹) from cool-white fluorescent lamps during cold storage improved the cutting quality. When chrysanthemum reaches a stability stage of growth, growers will provide treatment of cuttings with anti-ethylene agent 1-methylcyclopropene (1-MCP) to reduce the rooting (Serek et al., 1995).

2.2.2 Flowering Control and Dormancy of Chrysanthemum

Chrysanthemum flowers are available throughout the year by altering the photoperiod in the greenhouse. Long days are used to maintain vegetative growth of stock plants and cuttings prior to placing young plants under short day for flowering (Cockshull, 1985). Critical photoperiod of chrysanthemum is 12 hours or less for reproductive growth, 14 hours or more for vegetative growth. Growers can induce the flowering when the flower placing is at or below 14 hours.

However, there is a day-neutral breeding lines exist in chrysanthemum production (Anderson and Ascher, 2001). Juvenility has a close connection with physiological age of the meristem. Juvenility of chrysanthemum exist as cuttings from older stock become reproductive sooner than those from younger stock. However, plants eventually form a terminally reproductive structure called a crown bud, which rarely reaches anthesis; if the stock plants are kept under long day. Because of this reason, propagators must
renew stock plants up to four times a year depending on the cultivar grown (Cathey, 1969; Cathey and Borthwick, 1971; Cockshull and Kofranek, 1985). Besides, when petals of the flowers lost turgidity, flower abscission or petals became brown, the flowers were considered dead. A period between flower anthesis and flower death is considered as flower longevity. Flower death is included the condition when flowers drop, petal wilting or petal browning (Monteiro et al., 2002).

2.2.3 Floral Development of Chrysanthemum

Floral development is important to produce a high quality product of chrysanthemum. Chrysanthemum is a short day (SD) plant and cultivars are classified this fact due to the chrysanthemum response group, which is the number of weeks required to flower from the beginning of short day. Seven days to nine days are required for the first microscopic reproductive changes to be observed in the meristem.

For chrysanthemum flower, floral initiation is completed after 24 to 30 days. With this information, a producer can predict the number of leaves on future flowering stems by counting the visible leaves and adding the proposal number of microscopic leaves (Cockshull, 1985). Terminal buds development rate of chrysanthemum will be similar, without delay, under long day or short day after 28 days of growing. This fact is particularly true to chrysanthemum if the subtending flower buds have been removed (Ben-Jaacov and Langhans, 1969, 1971). When terminal flower buds of chrysanthemum begin to show petal color, plants can be moved from short day to long day without delay in development (Cathey, 1957; Cockshull, 1985).

2.3 Economy Value

Floriculture industry is one of the lucrative and profitable industries in Malaysia. It had emphasis floriculture industry is one of the potential industries in the Second National Agriculture Policy (1992-1997). Japan is the major export market for Malaysia floriculture production. Besides, Malaysia is also one of the main countries to supply tropical orchids, temperate cut flowers and dried foliages to Japan.
Import of floricultural products to foreign countries such as Japan indicates an increasing trend in Malaysia. It bought a profit from RM 64 million in the year of 1985 to RM 652 million in the year of 1997. It is further increased to RM 686 million in the year of 2001. In the past few years, Holland was the major supplier of cut flowers to Japan. However, the price is higher as compared to the other supplier countries. Due to the factor of price and flower freshness, Japan preferred floricultural products from neighboring countries including Malaysia. Chrysanthemum is the most popular cut flower in Japan when compared to other cut flowers (Auni et al., 2004).

Chrysanthemum is one of the most culturally rich flowers following after rose. It is globally second economically most important floricultural and ornamental crop species. For the last decade, chrysanthemums occupy 35% of the total cut-flower production in production value of flowers in Japan. Chrysanthemum has value of bring out improvement of living conditions and a greater enjoyment of life. In terms of chrysanthemum stem production per year (Teixeira da Silva, 2003), Japan is leading producing country (two billion), followed by the Netherlands (800 million), Colombia (600 million), Italy (500 million) and USA (300 million); and chrysanthemum as second place in the cut flowers' list; it is an important cut flower by sales value (UK market; Flowers and Plants Association, 2001).

2.4 Postharvest handling

In both developing and developed countries, a modern marketing chain cause increasing demands on ornamental products and there is a need for postharvest handling techniques that reduce retention of quality over long period (Wills et al., 2007). In recent years, the increased attention in postharvest horticulture had appeared when realization of faulty handling practices after harvest can cause large losses of produce. These losses also related the losses of substantial inputs of labor, materials and capital to grow. Modification of a postharvest handling method will result a changes in market value of a particular product. Competitors in agriculture career always forced to adapt with improved postharvest handling method to say in the business (Shewfelt et al., 1993). This showed how important that a well and consumable method will bring profit.
It is so important of postharvest handling toward horticultural produces are 'living' structures. During the growing stage of the crop plant in its agriculture environment, it is accepted and considered as a living, biological entity. However after harvest, the produce is considered as still living. As it continues to perform most of the metabolic reactions and it can maintain physiological systems although apart from the mother plant. Before choosing any suitable postharvest handling methods toward particular plants included crop plants and cut flower productions, it is necessary of understanding the feature of plants. They respire by taking up oxygen, giving out carbon dioxide and heat. Most important is that they also transpire by losing water to the surrounding environment (Wills et al., 2007).

During the growth of plant, losses due to respiration and transpiration are replaced from the flow of sap, which contains water, photosynthetic and minerals. After harvest, respiration and transpiration continue. Since the produce is removed from the normal source of water, photosynthetic and minerals, the produce depends entirely on its food reserves and moisture content. Therefore, the produce will loss moisture and respirable substrates and deterioration will increase in period of time. Crop production included vegetables, fruits and ornamentals are perishable after harvested from farm. Therefore, searching a suitable postharvest handling method can reduced the losses of produce and prolongs the vase life. However, it is very particular as every type of crop species has own suitable method. Flower species have high rates of respiration through glycosis of sugar translocated from leaves. Therefore, preservative solutions used by florist for cut flower production often contain sugar such as sucrose. Sugar is important as it is a carbohydrate source. It helps to maintain respiration rate and thus extend storage life (Wills et al., 2007).

After the process of harvesting chrysanthemum being done, stems of the flowers are out of water during the marketing process, the flowers should be recut and placed in warm 100 °F (38 °C) water (Sacalis, 1993). Growers usually use commercial prepared floral preservatives. However, larger firms often find more economical way to prepare their own solutions. Citric acid is used to mix with water to change pH to 3.5; besides a material that will control the growth of microorganisms [100 to 150 ppm hydroxyquinoline citrate (HQC)] and sucrose (lower than 3%) is also recommended by researcher (Hussein, 1994).
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