EFFECTS OF DIFFERENT PRESERVATIVES ON SHELF LIFE AND QUALITY OF GERBERA AND GLADIOLUS

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CERTIFICATE

*This is to certify that the thesis entitled, "**EFFECTS OF DIFFERENT PRESERVATIVES ON SHELF LIFE AND QUALITY OF GERBERA AND GLADIOLUS**" submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in Horticulture**, embodies the result of a piece of bona fide research work carried out by **MD. JAHANGIR ALAM**, Registration No. **13-05303**, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that any help or sources of information, as has been availed of during the course of investigation have been duly acknowledged.

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DEDICATION

Dedicated to my beloved parents and respected teachers of

Sher-e-Bangla Agricultural University

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*All the praises are due to **Almighty Allah**, the most Kind and Merciful, the most Beneficent and Compassionate, the Creator and the Sustainer of the whole universe, who has enabled me to complete this study.*

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ABSTRACT

An examination was carried out in the Postharvest Laboratory of Department of Horticulture, SAU during the period of January to February, 2019 to study the effects of different preservatives on increase shelf life of gerbera and gladiolus. For this experiment, spikes of gerbera and gladiolus were kept in T_0 (Tap water), T_1 (0.4 ppm 1-MCP + 4% sucrose), T_2 (50 ppm salicylic acid + 4% sucrose), T_3 (100 ppm salicylic acid + 4% sucrose), T_4 (0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_5 (0.4 ppm 1-MCP + 100 ppm salicylic acid + 4% sucrose), T_6 (50 ppm AgNO3 + 50 ppm citric acid + 0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_7 (100 ppm AgNO3 + 100 ppm citric acid + 0.4 ppm 1-MCP) + 100 ppm salicylic acid + 4% sucrose) and T_8 (1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar). The experiment was arranged in Completely Randomized Design. T_6 solution gave the best result in respect of water uptake, vase life and other parameters. The highest vase life of gerbera and gladiolus was 15.8 days and 14.8 days respectively in T_6 solution whereas it was 8.0 days and 7.0 days in control. Treatment with T_7 solution gave shelf life 14.6 days and 13.6 days for gerbera and gladiolus respectively. Conventional solution T_8 showed 12.8 days and 12.2 days for gerbera and gladiolus respectively. The highest solution uptake of gerbera and gladiolus was 62 ml and 113.4 ml respectively in T_6 solution whereas it was 20 ml and 50 ml in control. Treatment with T_7 solution uptake 58.4 ml and 102.20 ml for gerbera and gladiolus respectively. Conventional solution T_8 uptake 47 ml and 96.40 ml for gerbera and gladiolus. As T_8 solution (1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar) gives better performance, so it can be a suitable substitute of chemical preservatives in Bangladesh aspect.

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LIST OF ACCRONYMS AND ABBREVIATIONS

Biol.	=	Biology
et al.	=	And others
Hort.	=	Horticulture
i.e.	=	That is
CRD	=	Completely Randomized Design
SAU	=	Sher-e-BANGLA Agricultural University
Technol.	=	Technology
Viz.	=	Namely
ppm	=	Parts per Million
1-MCP	=	1-Methyl cyclopropane

CHAPTER I

INTRODUCTION

Cut flowers refer to flowers i.e. blossom of flower buds those are cut with branches, stems and leaves to be used for bouquets or decoration. Gerbera and gladiolus as cut flowers is increasing day by day its popularity in Bangladesh due to their long vase life and beautiful colors and have been ranked as the uppermost position in cut flowers.

Gerbera (*Gerbera jamesonii*) is popularly known as Transvaal daisy is one of the natures beautiful creation having colorful flowers of exquisite shape, size and bewitching color. It is one of the ten most popular commercial cut flowers in the world. According to the global trends in floriculture, it occupies the fourth place among cut flowers (Choudhary and Prasad, 2000). It is a member of Asteraceae family. The flowers are known as head or capitulum. It is widely used in bouquets and in dry flower crafts.

Gladiolus (*Gladiolus sp.*) is the member of Iridaceae family, which is one of the most important cut flowers in Bangladesh. It has gained popularity in many parts of the world owing to its unsurpassed beauty and economic value. It has been rated as the second most important popular flower in the world, especially from the commercial point of view (Hamilton, 1976).

Keeping quality is an important parameter for evaluation of cut flower quality, for both domestic and export market. Various factors influence the postharvest performance and the vase life of cut flowers. Maintenance of quality during postharvest period and enhancing postharvest life requires careful handling and some treatment.

Fresh cut flowers are highly perishable and tend to lose their aesthetic appeal within a relatively short time. In majority cases, cause of deterioration of cut flowers is blockage of xylem vessels by microorganisms which accumulate in the vase solution or in the vessels themselves. The cut surface of flower stalk is susceptible to attack by bacteria and fungi, resulting in pathological break down and death (Kader 1992). All along the marketing channel, there is enormous loss in the value of cut flowers which could be 50 per cent of the farm value (Bhattacherjee, 1999). The cut flowers are deprived of their natural resources of water and nutrients after detaching from mother plant. Ethylene concentration in ambient atmosphere affects the vase life of cut flowers (Jalili Marandi et al., 2011). Many flowers perish rapidly in response to ethylene. Therefore, it is

necessary to explore the ways and means to prolong the shelf life of the cut flowers while keeping the quality high.

Addition of chemical preservatives to the cut flowers is recommended to continue its physiological processes so that the longevity of the flowers can be extended by more number of days (Nair *et al*., 2003). Most of the cut flowers were kept in water but now a days, scientists have introduced many floral preservatives to improve the vase life of cut flowers. Investigations pertaining to extend the vase life of cut flowers by chemical treatments after harvest have been made with varying success. Several preservatives/chemicals i.e. silver nitrate, aluminium sulphate, 8-HQS, boric acid, citric acid, ascorbic acid, sucrose etc. have been used in different formulations and combinations to enhance the vase life of gerbera and gladiolus [Saini *et al*. (1994), Reddy *et al*. (1995), Reddy and Singh (1996), Sathyanarayana *et al*. (1996), Reddy *et al*. (1997)]. Doorn (1988) reported that treatment with ethylene (3 µl·liter^{-1}) for 24 h revealed little to no sensitivity as indicated by slight acceleration of petal wilting in only some cultivars. In contrast, ethylene removal during storage improved the subsequent. Use of floral preservative is the most economical and practicable method for extending the postharvest life of cut flowers (Salunkhe *et al.* 1990). Flowers remain fresh longer if they are placed in a suitable floral preservative (Nowak and Rundnicki 1990). Floral preservatives have been acidified by using citric acid and have usually included biocides to inhibit bacterial proliferation. Sucrose has been used with germicides as $AgNO_3$, because sugar treatment without germicides promotes bacterial proliferation, leading to shortening of the vase life. Some vase solutions as salicylic acid including sucrose extend vase life of cut flower. SA is considered to be a potent plant hormone because of its diverse regulatory roles in plant metabolism (Popova *et al.*, 1997). Its role is evident in ion uptake and transport (Harper and Balke, 1981), photosynthetic rate, stomatal conductance and transpiration (Khan *et al*., 2003). As an ethylene inhibitor, 1-MCP has been used to the postharvest treatment of cut flowers. Hassanpour Asil *et al.* (2013) reported that the application of 1-MCP extends the vase life of cut spray carnation 'Optima' flowers by retarding fresh weight (FW) loss, ethylene production, and chlorophyll and anthocyanin degradation. Celikel *et al.* (2002) also showed that pretreatment of 'Monalisa' and 'Stargazer' lilies with 1-MCP completely inhibited the ethylene response, but did not prevent normal senescence, wilting, and abscission of open flowers. The most common biocides used in

Bangladesh is house hold bleach (Sodium hypochlorite) which can effectively reduce microbial growth, specially bacteria. A solution of household bleach with sugar and citric acid as conventional solution works well for most of the cut flowers. The biocides in floral preservatives maintain clarity in the solution and prevent blockage of xylem vessel by microorganisms (Knee 2000). Already in the beginning of this century several experiments were conducted to study the vase life of cut flowers. Since then, a lot of work has been done on senescence, effect of sucrose (Ichimura *et al*., 1998) postharvest physiology, postharvest handling and vase life of cut flowers in many countries of the world. Therefore, the present study was done to fulfill the following objectives:

1. To investigate the effect of different preservatives on the postharvest life and physiological activity of cut flowers.
2. To increase shelf life and quality of cut flowers using different preservatives.
3. To find out the best combination of preservatives for enhancing the vase life of cut gerbera and gladiolus.

CHAPTER II

REVIEW OF LITERATURE

Gerbera and gladiolus are the most important cut flowers in the world and occupies a place of great prominence. Longer vase life is one of the most desired qualities in cut flowers. It is therefore essential to develop suitable techniques to improve the keeping quality of cut flowers. The first review on postharvest physiology of flowers was reviewed by Aarts (1957) on keeping quality of cut flowers. Flowers removed from the plant deteriorate much more quickly than those left on the plant under similar environmental conditions (Durkin and Kue, 1966). Literature pertaining to post harvest physiology of cut flowers is reviewed in detail by several workers (Rogers 1973; Halvey and Mayak 1979, 1981).

Cut flower is a complex delicate organ composed of different morphological units and their interrelationship determines postharvest longevity and quality. Extension of vase life of cut flowers involves two seemingly conflicting processes, the promotion of growth during the first phase and retardation of senescence process during second phase (Halvey and Mayak 1979). The literature pertaining to postharvest behavior of cut flowers as affected by different chemicals is reviewed under.

1.1 Response of Different Preservatives on Cut Flower (Gerbera)

Turgidity in plants and flowers is dependent upon a balance between the rate of water loss or utilization and water supply (Masterlenz 1953; Rogers 1962 and Tickner, 1942). A high level of turgidity is necessary for development of flower buds to full bloom maturity. It is also necessary for the continuance of normal metabolic activity in the cut flower (Rogers, 1973).

Continuous keeping of cut flower stems in vase holding solution leads to browning of stems. So, to prevent this, water must be changed every day or else treated with chlorine (Barendse, 1981)

Rogers (1973) reported that turgidity in plants and florets depends on the balance between the rate of water loss, utilization and water supply. The termination of vase life is characterized by wilting and therefore, many studies have been made for evaluation of events leading to the phenomenon of wilting (Halevy and Mayak, 1981).

Vase life of cut gerbera flowers are usually not too long as they wilt and starts to bend and these symptoms are considered to be caused by vascular blockage, which inhibits the supply of water to the flower.

Several methods to increase the vase life of cut flowers and keep their freshness for longer periods have been reported. Cut flowers should be free of any deterioration, as this is one of the principal entry points for decay organisms. A major form of deterioration in cut flowers is the blockage of xylem vessels by air and microorganisms that cause xylem occlusion (Elgimabi and Ahmed, 2009). Arnold (1930) first reported low water uptake in cut flowers due to blockage by bacteria and their degradation products. Two major factors affecting water absorption through conducting vessels and air embolism and the occurrence of vascular occlusion in cut flower stems. Vascular blockage begins at the cut end and moves upward in the stem with time (Durkin and Kue, 1966).

Steinitz (1982) opined that addition of sucrose to the solution increased the mechanical rigidity of the stem by inducing cell wall thickening and lignification of vascular tissues.

Sucrose is widely used in floral preservatives, which acts as a food source or respiratory substrate and delays the degradation of proteins and improves the water balance of cut flowers (Nair et al., 2003). Sugars alone, however, tends to promote microbial growth. Hence, the combination of sugars and biocides might extend the vase-life of cut flowers. AgNO3 or sucrose alone was less effective as compared to their combinations with regard to vase-life. Similar observation was made by Steinitz (1982) and Awad *et al.* (1986) in gerbera and zinnia, respectively.

Nowak (1989) reported that the best results were obtained when the inflorescences were pulsed in AgNO3 (200 mg/liter) or in HQC (200mg/liter) + sucrose (100g/liter) or in AgNO3 (200mg/liter) + sucrose (100g/liter) before transport and they were kept continuously in preservative solution consisting of 8 HQC (200mg/liter) + sucrose (30g/liter) after transport.

Burzo *et al.* (1992) reported that flowers held in distilled water or a preservative solution containing 2.5 per cent dextrose, 150 ppm 8 HQS and 200ppm potassium chloride up to 12 days at 20-23 and 60-65 per cent relative humidity. Pulsing gladiolus spikes with sucrose five per cent enhanced vase life over control (Nijasure *et al.*, 2004).

Aluminum sulphate (0.75 mM) increases in vase life by 3.5 days over control with improved quality of cut roses. In addition to HQS, many germicides, such as silver nitrate, aluminum sulphate, copper sulphate, cobalt chloride have been shown to inhibit bacterial growth in cut flower stems (Van Doorn, 1997; Van Meeteren, 2000).

Sophia Laurence recorded the maximum vase life among the five rose scion varieties Gladiator, Arjun, Sophia Laurence, Golden Times and Montezuma used in aluminum sulphate 70 ppm solution, while Montezuma recorded the minimum vase life (Karadi and Patil., 2007).

Longer vase life along with higher water uptake and more water loss was observed in rose cultivar 'cream prophyta' on application of aluminum sulphate at the rate of 600 ppm as compared to the control (Yogitha, 1998). Aluminum sulphate in vase water decreased the number of bacteria in the stems and increased the vase life with an increased fresh weight in cut roses (Doorn et al 1990; De.Stighter, 1978; Nagarajaiah 1992).

The investigation revealed that the best holding solution for cut gerbera blooms would be a combination of silver nitrate and sucrose. The vase-life was prolonged by about nine days by holding the flowers in solution containing 20 ppm AgNO3 + 4% sucrose (Nair *et al.,* 2003).

Silver nitrate ranging in concentration from 10 to 50 mg l-1, together with 5% sucrose as holding solution significantly increased the vase life of Christian dior cut roses; the optimum concentration of Silver nitrate was 20 mg l -1. The holding solution containing 5% sucrose + 20 mg l -1 AgNO3 also significantly increased the vase life of rose cultivars 'Eiffel Tower', 'Swartmore' and 'Yankee' but not 'Kings Ransom' and 'Confidence'. Silver thiosulphate complex was not as effective as Silver nitrate for the increase in vase life or in the reduction of microbial population (Saichol *et al.,* 1992).

The experiment revealed significant influence of sucrose and silver nitrate at different concentrations on the vase life of two roses (*Rosa hybrida*), namely Trika and Whisky Mac. In all the treatments containing sucrose and silver nitrate, the AgNO3 concentration at 150 ppm prolonged the maximum number of days in both the cultivars, which were 4.3 and 3.2 days more in Whisky Mac and Trika, respectively as compared to control with the average value of 5.3 days (Shahid., 2005).

Treatment with sucrose in combination with 8-hydroxyquinoline sulphate (HQS) extends the vase life of cut rose flowers and the vascular occlusion may be responsible for short vase life because HQS inhibits vascular occlusion of cut rose stems (Ichimura *et al.,* 1999).

In comparison to other antimicrobial agents, ClO2 and 8hydroxyquinoline sulphate (8-HQS) were more effective in extending the vase life of Gerbera cultivars 'Julia', 'Lorka' and 'Vilassar' when included in vase water containing 0.2 g l−1 citric acid and 10 g l−1 sucrose (Macnish and Leonard., 2010)

Suneetha (1994) reported that the maximum vase life in three cultivars of gladiolus viz., 'Her Majesty', 'Vinks glory' and 'Oscar' was recorded in a holding solution of 5 per cent sucrose plus 600 ppm 8HQS. In case of 'Her Majesty' sucrose plus AgNO3 (100 or 200 ppm) solutions were also equally effective.

Preservative solution containing 8- HQS (150ppm) plus sucrose (2 per cent) increased vase life and improved quality of flowers, reduced ethylene production from flowers, inhibited microbial contamination and maintained structural role of vascular cambium tissue in the stem of Delphinium (Song *et al.,* 1995).

All holding solutions must essentially contain two components viz., sugar and germicides. The sugars provide a respiratory substrate, while the germicides control harmful bacteria. The improvement in vase-life of cut flowers in 20 ppm silver nitrate (AgNO3) solution might be due to the fact that it is a very effective biocide, which completely inhibits the microbial growth (Nair *et al*, 2003). It is in conformity with the findings of Ketsa et al, (1995) who opined that AgNO3 prevented microbial occlusion of xylem vessels in Dendrobium, thereby enhancing water uptake and increasing longevity of flowers.

The test solutions were distilled water (control), 0.1 M sucrose and 0.2mM1,1-dimethyl-4-(phenylsulfonyl) semi carbazide (DPSS) solutions.8Hydroxyquinoline sulphate at 200mg l-1 was added to each solution as a germicide. (Shigeru *et al*.,2005).

In addition to HQS, many germicides, such as silver nitrate and aluminum sulphate, have been shown to inhibit bacterial growth in cut rose stems (Van Doorn, 1997). The germicide 8-hydroxyquinoline sulphate (8-HQS) is one of the very important preservatives used in floral industry (Elgimabi and Ahmed, 2009).

Several preservatives/chemicals i.e. silver nitrate, aluminum sulphate, cobalt sulphate, 8-hydroxyquinoline sulphate, boric acid, citric acid, ascorbic acid, sucrose etc. have been used in different formulations and combinations to enhance the vase life of tuberose (Saini *et al*., 1994; Reddy et al. 1995; Reddy and Singh 1996; Sathyanarayana *et al*., 1996; De and Barman, 1998).

The commercial cut flower preservatives spring and chrysal were compared with a mixture prepared from 40mg silver nitrate, 50mg sodium benzoate, 30mg sugar, 7.5 mg aluminum sulphate and 2mg kinetin per litre of water for extending the vase life of cut roses, Carnations, Gerbera and Gypsophila. The experiment mixture gave the longest vase life (Yldrm *et al.,* 1995).

An experiment was conducted to compare the natural and chemical floral preservatives in cut gerbera in increasing the vase life. Among the preservatives tested, 50% coconut water (natural floral preservative) was proved to be the best in extending the vase life of cut gerbera flowers, followed by 4% sucrose + 20 ppm AgNO3, 60% coconut water and 6% sucrose + 30 ppm AgNO3. There was no significant difference between the best two treatments (Nair *et al*., 2000).

Gerbera jamesonii cv. Local Red flowers were treated with 4, 6, 8 and 10 % sucrose and 150,200 and 250 ppm silver nitrate for 24h to determine the effect of pulsing on the shelf life of cut flowers. Pulsing with 4% sucrose or with 250 ppm of silver nitrate for 24 h increased the vase life by 3 days compared to the control (7 days). The maximum vase life of flowers was 10 days (Nagaraj *et al*., 2000).

Chong *et al*., (1988) reported that the solution containing sucrose (5%) + silver nitrate (50ppm) + 8-HQ (200 ppm) extended the vase life of carnation flowers up to 2.4 times compared to control. Cut rose cv. Gladiator flowers showed a long vase life when held in 300 ppm aluminum sulphate + 5 per cent sucrose + 200 ppm 8-HQC+ 300 ppm citric acid (Patil and Singh, 1995).

Suma (2000) reported that lowest differences between weight of alstromeria cut flowers by treating with a combination of 0.2 mM silver thiosullphate + 4 per cent sucrose + 200 ppm 8- hydroxyl quinoline sulphate.

Chikkasubbanna and Sharada (2002) reported in carnation cutivar Sunrise recorded maximum vase life of 15.80 days in 100 ppm silver nitrate + 4 per cent sucrose + 200 ppm 8-HQ compared to 7.40 days in control while in cultivar Pentara, maximum vase

life of 10.80 was recorded in 0.4 mM silver thiosulphate + 6 per cent sucrose + 400 ppm hydroxy quinoline as against control (4.80 days).

Chikkasubbanna and Yogitha (2002) reported in rose cultivar Cream prophyta recorded a maximum vase life of 16.80 days in 600 ppm aluminum sulphate + two per cent + 150 ppm 8-HQS compared to control (13.80 days), while in cv. Sacha, the maximum vase life (15.60 days) was noticed in 400 ppm aluminum sulphate + one per cent + 150ppm 8-HQS as against 12.80 days of vase life in control.

Cut gerbera variety Scilla showed a maximum vase life (16 days). When held in 200 ppm hydroxy quinoline sulphate + 100 ppm cobalt +4 per cent sucrose (Dasgupta, 2006).

Stem break occurs when direct uptake of water is inhibited by bacterial activity than indirect uptake through cavity. This also depends on the season for example in winter this is rarely observed, where as in summer 90 to 100 per cent flower were affected. This could be prevented by pretreating the stalks by sodium hypochlorite or silver nitrate in the vase water (Meeteren, 1978).

Prevention of stem break and increased longevity of cut flowers could be achieved by using a solution containing an antimicrobial agent, an acidifying agent and sucrose either applied continuously or as a pulsing treatment (Abdul khader, 1986).

1.2 Response of different Preservatives on Cut Flower (Gladiolus)

A study was undertaken by Gowda and Murthy (1994) to ascertain the effect of optimum level of sucrose along with metallic salts on the postharvest life of gladiolus. The maximum vase life of 14 days was observed in flower spikes held in sucrose 2 percent and 0.5 mμ $Al_2(SO4)_3$ (alluminium sulphate) followed by 0.25 mμ also along with sucrose 2 percent (12 days). All the treatment combinations tried, improved the vase life of cut gladiolus compared to control (6 days).

Reddy *et al.* (1994) noted that quinoline salts and sucrose mixtures were good for extending the vase life and improve the quality of gladiolus cut flower. However, treatment with 200 ppm 8-HQS and 4% sucrose increased cut flower life, by increasing the water uptake and maintaining higher fresh weight of flowers.

Creating a light moisture stress by holding irrigation for 3 days prior to harvest of gladiolus spikes resulted in maintenance of better water relations, enhanced floret

opening and extended vase life maximally (9 days) compared to the least (6 days) in those irrigated daily (Murali and Reddy, 1994). It has been demonstrated by Reddy and Murali in 1994 that dipping the gladiolus (cv. Mansoer Red) corms in 75-100 ppm concentration of Triadime for improved postharvest water relations and vase life of spikes.

Opening of gladiolus spikes in an STS solution maintains higher fresh weight by encouraging more water uptake, leading to enhance longevity of florets and vase life of the spike. According to Reddy and Murali (1994), STS 0.5 mM was found best for increasing water uptake and extending the longevity of cut flowers.

Different concentrations of sucrose (0 %, 2 % and 4 %) and cobalt (0 ppm, 100 ppm and 500 ppm) effective in increasing the water uptake, water loss, percent floret opening, vase life and fresh weight of gladiolus spikes when these solutions were used singly by Gupta et al. (1994). But in combination their solution was found more effective in maintaining an increased pattern of water uptake and water loss and decrease in the water loss/water uptake ratio. However, the spikes held in 2 % sucrose and 300 ppm cobalt (Co) solution was helpful in the proper development and full expansion of flowers in a vase and in maintaining improved water status.

Ezhilmathi *et al.* (2007) conducted an experiment to study the effect of 5 sulfosalicylic acid (5-SSA) on the vase life of cut flowers of Gladiolus grandiflora variety 'Green Willow'. The vase solution having 5-SSA significantly increased vase life, cumulative uptake of vase solution, number of opened florets and decreased the number of unopened florets compared to the controls.

AL-Humaid (2004) conducted an experiment to find out the effect of biocide on postharvest quality and vase life of cut gladiolus. Vase life was significantly improved by placing spikes in vase solution containing antibiotics (200 ppm penicillin + 250 ppm streptomycin) and glucose (5, 10, or 20%). The addition of the biocide to the preservative solution reduced the bacterial counts in the solution, inhibited the microbial growth, improved flower-opening rates and reduced flower deterioration rate. Although there were positive proportional relationships among sugar concentration (up to 10%) and total bacterial counts in the solution, the addition of the biocide reduced the bacterial counts, resulting in the improvement of postharvest quality of tested cultivars. The highest and lowest number of opened and deteriorated flowers,

respectively, was achieved when the preservative solution contained a mixture of biocide and 20% glucose. Presence of biocide in the vase solution reduced both total carbohydrates and chlorophyll contents in the leaves of the cut gladiolus spikes.

Singh and Sharma (2001) conducted an experiment to study the effect of sucrose in combination with metal salts on the postharvest life of pulsed (20% sucrose for 24 hours) gladiolus spikes cv. 'White Properity'. The combination of sucrose (5%) and metal salts 8-hydroxyquinoline citrate (8-HQC) 600 mg/l increased the vase life of cut gladiolus spikes.

Garibaldi and Deambrogio (1989) conducted an experiment with sucrose, 8-HQS, 3, 4, 5-T (Trichlorophenol) and distilled water for prolonging vase life of gladiolus. It was observed that sucrose was significantly better than distilled water for preserving cut flowers of cultivar Priscilla and Moana.

Anserwadekar and Patil (1986) conducted an experiment to study the vase life of gladiolus. The treatments were 6% sucrose, GA3 at 60 ppm and distilled water. It was observed that sucrose maintained prolonged vase life for 11 days than other treatments.

Merwe *et al.* (1986) conducted an experiment to study the effects of sucrose uptake from a vase medium on the starch metabolism of senescing gladiolus inflorescence. The treatments were sucrose solution of different concentrations. It was observed that the vase life, general appearance, fresh mass and volume of medium uptake of the inflorescences improved with sucrose treatment. It was recorded that a concentration of 30 g sucrose/litre (i.e. 3% sucrose) was the most effective treatment.

Mayak *et al.* (1973) observed that gladiolus flowers when treated with 1 mM STS (an anti-ethylene compound) for 2 hours improved the opening of the small buds and consequently the postharvest life of the cut stems.

Flowers of gladiolus cv. Black Jack were placed in conical flasks containing of 2 and 3% of sucrose, aluminium sulfate (0.5 and 1.0 µM), aluminium chloride (0.5 and 1.0 µM) or calcium sulphate (0.5 and 1.0 µM) solution. Longest vase life (18.3 days) was with 1.0 µM aluminium sulphate, follwed by 3% sucrose (17.0 days) and 2% sucrose (15.3 days). Shortest vase life (9.1 days) was in the control. The highest uptake of solution (48.0 ml) was with 1.0 with 1.0 µM aluminium sulphate and the lowest uptake (30.6 ml) in the control. The increase in vase life due to sucrose may result from decreased moisture stress and improved water balance (Gowda and Gowda, 1990).

1.3 Response of Different Preservatives on Other Cut Flowers

Hassan and Ali (2014) cited that Silver thiosulphate (STS) is the most widely used substance as ethylene binding inhibitor. The benefits of using STS are so great that it is mandatory to be used with many species of flowers entering the flower auctions. STS appears to be having also further benefits than as a biocide.

Motaghayer and Esna-Ashari (2009) cited that there are different flower preservatives that provide water and energy which are required to improve flowers vase-life and to keep their quality over the period of presentation. Moreover, required energy for cell activities is prepared by sugars that oxidize in mitochondria and results in preservation of other organelles structure and function.

Torre *et al*., (2002) showed that CaCl2 treatment promoted bud opening and delayed the decrease in both membrane proteins and phospholipids and increased ATPase activity in the aging petals of rose.

Esna-Ashari (2009) showed that both hydroxyquinoline citrate (HQC) and Hydroxyquinoline sulfate (HQS) have anti-bacterial and anti-ethylene effects. This study ascertained the postharvest quality and vase life of cut rose using different vase solutions continuously treated.

Islam *et al.,* (2003) suggested that vase life was affected only when the commercial preservative Chrysal Clear (CC) or sucrose with 8hydroxyquinoline sulphate (HQS) compared with the water control (reverse osmosis water). Use of sugar combined with HQS in the vase solution are important factors for prolonging the vase life of Eustoma.

O'Donoghue *et al*., (2002) suggested that vase solutions containing sugar can improve the vase life of any cut flower crops. Since cut sandersonia flowers supplied with 2% sucrose are firmer during wilting compared to water-fed controls. Effects of sucrose treatment extend to alterations in cell wall structure in the floral tissues, which may influence the wilting-related flower softening.

Huang and Chen (2002) Conducted an experiment to measure the effects of pulse treatments of BA, sucrose, and BA before, after, or with sucrose, on the vase life of cut Eustoma flowers. BA pulse at 50 mg(.)L-l before 4% sucrose promoted the longevity of cut Eustoma flowers better than other treatments. Simultaneously, sucrose, glucose, and mannose concentrations in flowers during vase periods were maintained at higher

levels in double pulse treatments than in the single pulses. Ethylene production in flowers 2 days after vase treatment was highest in the BA treated flowers; intermediate in flowers pulsed with BA before, after, or with sucrose; and lowest in sucrose-treated flowers. Although a BA pulse increased ethylene production over that of controls, it inhibited senescence in cut Eustoma flowers. Respiration in flowers pulse-treated with sucrose or with BA before, after, or with sucrose, was significantly higher than that in controls. Results suggest that the vase life of cut Eustoma flowers is improved by either BA or sucrose in vase solution and especially when BA was pulsed before the sucrose pulse.

Kawabata and Sakiyama (1999) found that the percentage of flowers that opened with normal color was higher in HQS + Sucrose and Chrysal clear solution compared to HQS alone and RO water. Treatment with sucrose increased the anthocyanin concentration in flower petals as well as extended the vase life. Carbohydrate supply seems sufficient for pigmentation, and other metabolites may not be required in pigment formation in Eustoma flower.

Ketsa *et al*., (1995) opined that AgN03 prevented microbial occlusion of xylem vessels in Dendrobium, thereby enhancing water uptake and increasing longevity of flowers.

Steinitz (1982) opined that addition of sucrose to the solution increased the mechanical rigidity of the stem by inducing cell wall thickening and lignification of vascular tissues of cut gerbera flower stalks.

Rogers (1973). Confirmed that sucrose helps maintaining the water balance and turgidity. Hence, addition of sucrose to the holding solution might have led increased uptake of the holding solution that ultimately led to increase vase life of cut flowers. Islam et al. (2003) suggested that vase life was affected only when the commercial preservative Chrysal Clear (CC) or sucrose with 8hydroxyquinoline sulphate (HQS) compared with the water control (reverse osmosis water). Use of sugar combined with HQS in the vase solution are important factors for prolonging the vase life of Eustoma.

Huang and Chen (2002) suggested that Pulsing with gibberellic acid at 10 or 20 mg/L plus 8-hydroxyquinoline sulfate (200 mg/L) for 24 h followed by continuous sucrose treatments (4 or 8%) plus 8hydroxyquinoline sulfate extended the vase life and significantly promoted flower bud opening as compared with the 8-hydroxyquinoline

sulfate controls. Cut stems continuously placed in solutions containing sucrose produced less ethylene than those without sucrose. It is suggested that a gibberellic acid pulse at 10 mg/L followed by continuous sucrose treatment at 4% be recommended to growers for extending the vase life and enhancing flower bud opening in cut P. tuberosa.

Akbar *et al*. (2001) conducted an experiment on tuberose using CaC12.2H20, AgN03, ascorbic acid and Tri-Miltox Forte (a fungicide) solutions with various concentrations to see their effects on keeping quality and vase life of the flowers. CaC12.2H20, AgN03 and Tri-Miltox Forte delayed flower opening as compared to ascorbic acid and standard preservative, but stood at par with control. CaC12.2H20 at concentrations of 750 to 1250 ppm and Tri-Miltox Forte at 1500 ppm resulted in minimum flower wilting after six days. AgN03 was found to have adverse effects on fragrance of the flowers. Water uptake by the spikes was more in those kept in standard preservative and CaC12.2H20 750 and 1000 ppm solutions. However, AgN03 50 and 200 ppm solutions resulted in maximum vase life (8 days) of cut flowers. Percentages of flowers opened and wilted were significantly negatively correlated with the vase life.

Bakhsh *et al.,* (1999) conducted an experiment to find out the effect of different chemicals on vase life and quality of cut tuberose. Vase life was increased three times by using a solution containing 200 ppm silver nitrate (AgN03) and 4m M silver thiosulfate (STS). Pulsing cut tuberose stems in a solution containing glucose and sucrose prolonged vase life and improved quality. Flower harvested at right bud stage had significantly longer vase life compared to flowers cut at half open bud stage. The quality of flowers was also improved greatly by pulsing flowers in silver nitrate (AgN03) and silver thiosulfate (STS) chemicals.

Reid (1996) tested the effect of putting freshly-cut tuberose spikes in a preservative vase solution containing 8-HQC and 2% sucrose. The results demonstrate that holding flowers in preservative increased floret opening and vase life by over 30%.

Reddy and Singh (1996) studied the effect of aluminium sulphate and sucrose on the postharvest physiology of tuberose flower spikes. Aluminium sulphate in combination with sucrose significantly enhanced the vase life and quality of tuberose spikes by increasing the water uptake, maintaining better water balance and higher

fresh weight for longer periods. Optimum concentrations for the combined treatment were 0.50 mm aluminium sulphate and 4% sucrose.

Gowda and Gowda (1990) conducted an experiment where cut polianthes tuberosa spikes were placed in solutions containing 2% sucrose and aluminium sulphate at 200 or 400 ppm and held for up to 12 days. The vase life was longest (12 days) in 1% sucrose + 200 ppm aluminium sulphate, and 2% sucrose + 400 ppm aluminium sulphate.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the Postharvest Laboratory of Department of Horticulture, Sher-e- Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from January to February, 2019 at room condition to study the postharvest physiology of gladiolus and tuberose and to find out the effective treatment that can increase their postharvest life.

1.4 Design of Experiment

The experiment was laid out in Complete Randomize Design (CRD) with single factor.

The factor is

- Different preservatives

There were 9 treatments in the experiment including the chemical preservatives and water.

These were –

T_0 =Tap water (Control)

T_1 =0.4ppm 1- MCP) +4%Sucrose

T_2 =50ppm Salicylic Acid + 4% Sucrose

T_3 =100ppm Salicylic Acid + 4% Sucrose

T_4 =0.4ppm (1- MCP) + T_2

T_5 = 0.4ppm (1- MCP) + T_3

T_6 =50ppm $AgNO_3$ + 50ppm Citric Acid + T_4

T_7 =100ppm $AgNO_3$ + 100ppm Citric Acid + T_5

T_8 =1L Warm water + 1/4Tea spoon Bleach +10ml Citric Acid +1/2 Spoon Sugar

Stick of Gerbera and Gladiolus were kept in different glass bottle randomly, containing vase solution of different chemicals. Each treatment had 5 replications.

1.5 Preparation of vase solution

Different preservatives were used to prepare vase solutions in this experiment. The vase solutions were made up with water and they are as follows:

1.6 4% sucrose solution

40 gm sucrose was dissolved in one liter of water to make 4% sucrose solution.

1.7 0.4ppm (1-MCP) solution

0.4 mg (1-MCP) was added with one liter of water to make the solution.

1.8 50 ppm salicylic acid solution

50 mg of salicylic acid was dissolved in one liter of water to make the solution.

1.9 100 ppm salicylic acid

100 mg of salicylic acid was dissolved in one liter of water to make the solution.

1.10 50 ppm $AgNO_3$ solution

50 mg of $AgNO_3$ was dissolved in one liter of water to make the solution.

1.11 100 ppm $AgNO_3$ solution

100 mg of $AgNO_3$ was dissolved in one liter of water to form the solution.

1.12 Control solution

No preservative was added here. Tap water was used. Tap water was collected from the Postharvest Technology laboratory.

1.13 Maintaining pH level

Adequate amount of citric acid was added with the solutions for lowering the pH level of specific solutions. The pH of the solutions was maintained at 4.5-5.0.

1.14 The Flower Vase

Glass bottle (250 ml) was used as flower vase in this experiment. After preparing the solutions each glass bottle was filled in with 200 ml of desired solution. Each bottle was marked for easy identification. Water level was marked with a permanent marker after placing flower spike. The mouth of the glass bottles was open.

1.15 Collection of Flower Spikes

1.15.1 Gerbera

Gerbera was collected from Godkhali village under Jhikergacha upazilla of Jashore district. The spikes were harvested early in the morning from the field with a sharp knife to avoid mechanical damage. Harvesting was done after opening of flower. The spikes were placed in cool water just after harvesting.

1.15.2 Gladiolus

Gladiolus was collected from same area after opening of the lowest floret. Same procedure as gladiolus was followed during flower spike collection.

Placement of spikes on the vase

Stems were cut at a length of 40 cm in case of gerbera and 70 cm in case of gladiolus and placed in the vase solutions after removing the lower leaves and allowing no leaf in the vase solutions. Slanting cut was made to create a wider surface area for increased water absorption. (Plate :1)

1.16 Collection of data

Data was collected on the following characters-

1.16.1 Gerbera

Solution uptake

Days taken for discoloration of petal

Days taken for petal fall

Vase life

1.16.2 Gladiolus

Solution uptake

No. of days taken for opening of basal floret

No. of florets open at senescence of basal florets

Vase life

1.17 Solution uptake

Solution uptake by inflorescences was measured every day at 5.00 P.M. by raising the fluid in the water bottle to the marked level. Solution uptake was measured until the inflorescence had become unacceptable.

1.18 Vase life evaluation

Vase life can be defined as the number of days from the moment of placing the flowers in the vase (day 0) until the moment when their condition was considered unacceptable.

The condition of the flowers was rated daily until the moment when they were considered unacceptable.

1.19 Light supply

For sufficient and equal distribution of light for each treatment, four florescent tube lights were provided in the laboratory during the experimental period. A lighting period of 10 hour was maintained for the flowers from 8 A.M. to 6 P.M. daily.

1.20 Statistical analysis

The data collected on different parameters were analyzed statistically using Statistic 10 software to find out the significance of variation resulting from the experimental treatments. Least Significant Difference (LSD) test was applied to compare the differences among the treatment means at 5 % probability level.

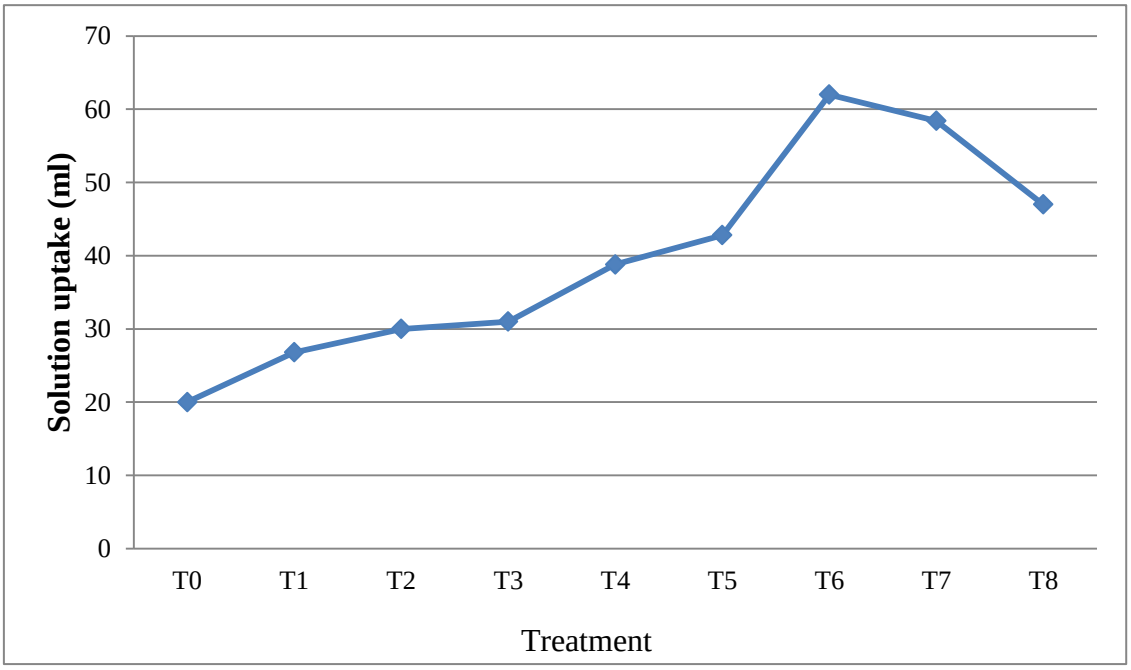
CHAPTER IV

RESULT AND DISCUSSION

Data of the different parameters were analyzed statistically and the results have been presented in tables 1 to 2 and figures 1 to 4. Some plates were also presented to observe the condition of flowers at different stages. Obtained results are discussed in this chapter.

1.21 Solution uptake

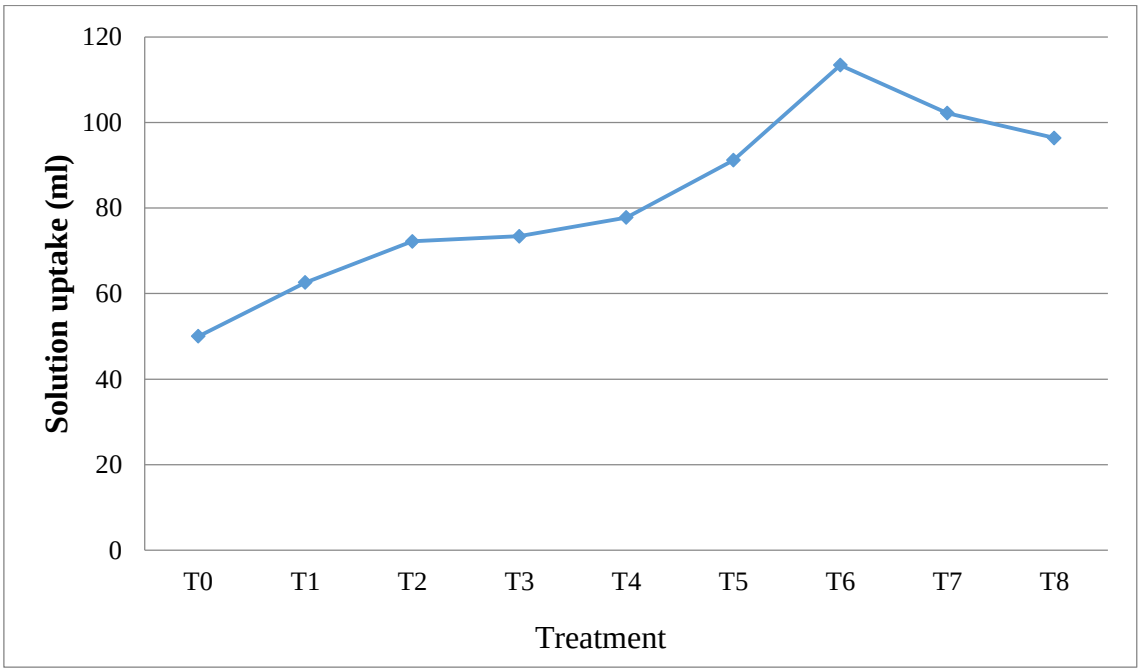
Total water uptake was significantly influenced by different preservatives solution. Both in Gerbera and Gladiolus. Results regarding the water uptake by the cut spikes of gerbera (Fig.1) and Gladiolus (Fig2) showed that maximum water was taken up by the spikes kept in treatment T_6. Minimum water was taken up in control treatment and that was 20 ml and 50 ml in Gerbera and Gladiolus respectively. Figure 1 and figure 2 showed that in control treatment both in Gerbera and Gladiolus water uptake was significantly lower from the beginning up to the end of vase life compare to other treatment. Maximum water was taken up in treatment T_6 and the average was 62 ml and 113.4 ml in Gerbera and Gladiolus respectively.



T_0(Tap water) , T_1(0.4 ppm 1-MCP + 4% sucrose),T_2(50 ppm salicylic acid + 4% sucrose),T_3(100 ppm salicylic acid + 4% sucrose),T_4(0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_5(0.4 ppm 1-MCP + 100 ppm salicylic acid + 4% sucrose), T_6(50 ppm AgNO3 + 50 ppm citric acid + 0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_7(100 ppm AgNO3 + 100 ppm citric acid + 0.4 ppm 1-MCP) + 100 ppm salicylic acid + 4% sucrose), and T_8(1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar)

Figure 1: Effect of preservatives on solution uptake (ml) of gerbera

Then water was taken up in treatment T_8 and the average were 47 ml and 96.4 ml in Gerbera and Gladiolus. According to the result, there were statistically significant among T_6, T_7 and T_8 both of gerbera and gladiolus. There were no significant difference in case of treatment T_2 and treatment T_3 for both flowers.



T_0(Tap water) , T_1(0.4 ppm 1-MCP + 4% sucrose),T_2(50 ppm salicylic acid + 4% sucrose),T_3(100 ppm salicylic acid + 4% sucrose),T_4(0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_5(0.4 ppm 1-MCP + 100 ppm salicylic acid + 4% sucrose), T_6(50 ppm AgNO3 + 50 ppm citric acid + 0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_7(100 ppm AgNO3 + 100 ppm citric acid + 0.4 ppm 1-MCP) + 100 ppm salicylic acid + 4% sucrose), and T_8(1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar)

Figure 2: Effect of preservatives on solution uptake (ml) of gladiolus

An ideal flower preservative is that which allows water absorption in flower tissues (Salunkhe *et al*. 1990). Water loss from the flowers continues through transpirations. The preservative solution maintains water balance and flower freshness and saves from wilting resulting in enhanced vase life. Bacteria grow quickly in any solution containing sugars and other organic matter. They start to grow at the base of cut stems as soon as flowers are put into water. Chemical preservatives contain anti-microbial compounds or biocides to retard the growth of bacteria.

Vascular blockage of stems caused water deficit that reduced water uptake. The effective germicide inhibits vascular blockage and can extend water uptake of bacteria. Germicide containing solution helps to reduce microbial growth as well as leads to

higher water uptake. Sucrose helps in maintaining the water balance and turgidity. For this, sucrose might have led to incease uptake of the solution.

Plate 1: Placement of flower spikes on glass bottle (A: Gerbera ; B: Gladiolus)

1.22 Days taken for petal discoloration (gerbera)

Preservatives play an important role to delay in petal discoloration. Results regarding days taken for petal discoloration by the cut spikes of gerbera showed that maximum days was taken for petal discoloration by the spike kept in treatment T_6. Average 16.8 days was taken for petal discoloration. Average 15.2 days and 14.2days was taken in treatment (T_7) and (T_8) respectively. There were significantly different among T_6, T_7 and T_8. There was no significant difference between treatment T_2(11.2days) and treatment T_3(11.4days), treatment(T_4) and treatment (T_5) statistically similar. Minimum days was taken for petal discoloration in control treatment and the average was 9.2 days.

Table 1: Effect of preservatives on days taken for petal discoloration and petal fall

Preservatives	Days taken for discoloration of petal	Days taken for petal fall
T_0	9.20 g	10.20 h
T_1	10.20 f	11.20 g
T_2	11.20 e	12.40 f
T_3	11.40 e	13.00 ef
T_4	12.80 d	13.80 de
T_5	13.00 d	14.00 d
T_6	16.80 a	17.60 a
T_7	15.20 b	16.20 b
T_8	14.20 c	15.00 c
LSD at 5%	0.93	0.90
CV%	5.71	5.10

T_0(Tap water) , T_1(0.4 ppm 1-MCP + 4% sucrose),T_2(50 ppm salicylic acid + 4% sucrose),T_3(100 ppm salicylic acid + 4% sucrose),T_4(0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_5(0.4 ppm 1-MCP + 100 ppm salicylic acid + 4% sucrose), T_6(50 ppm AgNO3 + 50 ppm citric acid + 0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_7(100 ppm AgNO3 + 100 ppm citric acid + 0.4 ppm 1-MCP) + 100 ppm salicylic acid + 4% sucrose), and T_8(1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar)

1.23 Days taken for petal fall (gerbera)

Gerbera flowers opened and had a longer vase life after treatment with commercial preservatives followed by a solution containing sucrose, biocide ,1-MCP and salicylic acid. Petal of gerbera became discolored and started to fall down after senescence of the flowers. It was observed from (Table 2) that different preservatives had significant role in days taken for petal fall. The maximum days taken for petal fall was recorded in treatment T_6. The chemical preservatives that may be necessary elements needed for cut flowers i.e. food sources, anti-microbial agent, ethylene inhibitor, pH lowering compound and others. Probably that was the reason of taking more days to fall down the petal of the flowers. Maximum 17.6 days was taken for petal fall in treatment T_6 .16.2 days and 15.0 days was recorded for petal fall of the flowers in treatment T_7 and T_8. There were statistically significant among T_6, T_7 and T_8 treatment. Average 14 days was taken to fall down the petal in case of treatment T_5. The minimum days was taken for petal fall in the control treatment and the average was 10.20 days. Statistically there is no significant difference between the flowers under treatment T_4 (13.8) and T_3 (13).

It was evident from table 2 that solution containing 1-MCP, Sucrose, citric acid, $AgNO_3$ in treatment T_6 extended the vase life of gerbera. So, maximum days was taken to fall down of petal in case of combination of preservatives.

1.24 Number of days taken for opening of basal floret (gladiolus)

Table 2: Effect of preservatives on number of days taken for opening of basal Petal and number of florets open at senescence of basal floret

Preservatives	Number of days taken for opening of basal petal	Number of floret open at senescence of basal floret
T_0	4.80 a	2.20 g
T_1	3.80 b	3.20 f
T_2	3.60 b	4.20 e
T_3	3.40 bc	4.60 de
T_4	3.20 bc	5.00 cd
T_5	2.80 cd	5.80 b
T_6	2.20 d	6.80 a
T_7	2.40 d	6.20 ab
T_8	3.20 bc	5.60 b
LSD at 5%	0.62	0.78
CV%	14.79	12.50

T_0(Tap water) , T_1(0.4 ppm 1-MCP + 4% sucrose),T_2(50 ppm salicylic acid + 4% sucrose),T_3(100 ppm salicylic acid + 4% sucrose),T_4(0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_5(0.4 ppm 1-MCP + 100 ppm salicylic acid + 4% sucrose), T_6(50 ppm AgNO3 + 50 ppm citric acid + 0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_7(100 ppm AgNO3 + 100 ppm citric acid + 0.4 ppm 1-MCP) + 100 ppm salicylic acid + 4% sucrose), and T_8(1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar)

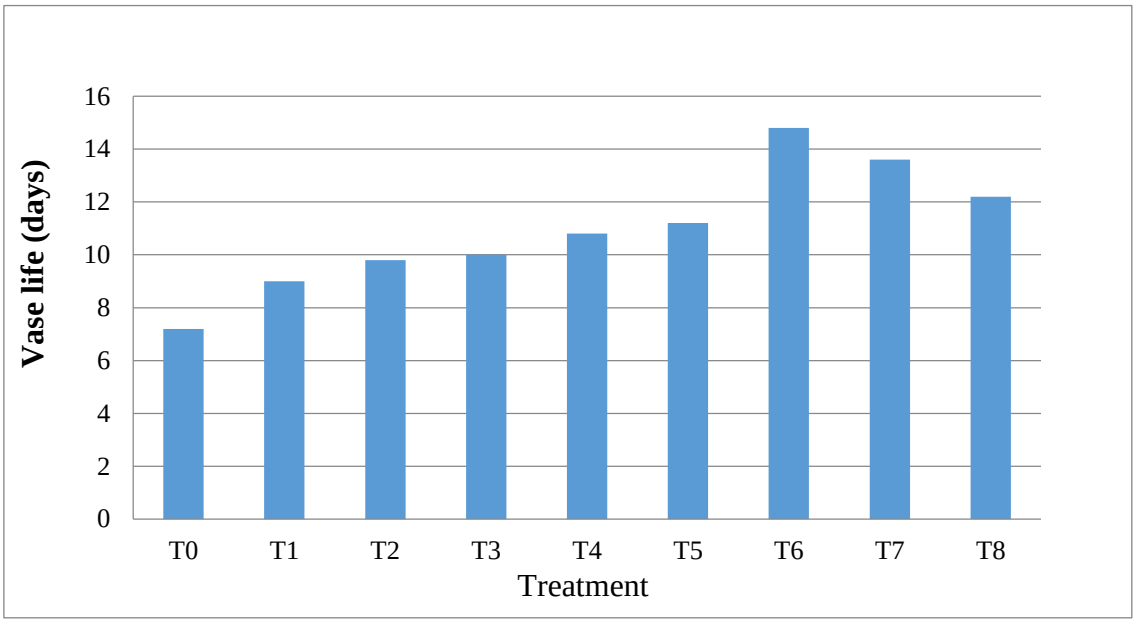
According to experimental results we concluded that the early floret opening was recorded in treatment T_6 and average was 2.2 days. 2.4 days and 3.2 days were recorded in case of treatment T_7 and T_8 respectively for floret opening. Besides 3.4days and 3.6 days were recorded under treatment T_3 and T_2) There are nonsignificant followed by T_6, T_7 and T_8 treatment and T_2,T_3 treatment.

For basal floret opening, control treatment required more time than the other treatment and the average was 4.8 days. In the control treatment, there was no sugar or energy supply. This might be due to the fact that sucrose provides energy for growth and accelerated the opening of flower bud (Farnham *et al.*,1972).

1.25 Number of florets open at senescence of basal florets (gladiolus)

Maximum number of florets open in the treatment (T_6) and the average number of florets was recorded as 6.8. Maximum number of floret open at senescence of basal floret was recorded in treatment (T_7-6.2), (T_5-5.8), (T_8-5.6) (T_4-5.00), (T_3 -4.6), (T_2-4.2) compared to control. The maximum number of florets opening at a time was recorded in treatment (sucrose 4% + 0.4 ppm 1-MCP + 50 ppm salicylic Acid + 50 ppm $AgNO_3$ + 50 ppm Citric acid) whereas the minimum was recorded in control (T_0-2.2). From the above result, there is nonsignificant between T_6 and T_7 treatment. Therefore, there is also nonsignificant among T_2(4.20) and T_3(4.60). The effect of $AgNO_3$ on maximum number of florets open at a time were apparent due to its antimicrobial nature, which helped in preventing vascular blockage and finally increasing water uptake. Likewise, SNP act as vase solution disinfectants and inhibited the pathogen growth, followed by increasing water uptake and TSS (Lazer *et al.,* 2008). The findings of this investigation confirm the observations of earlier workers, Choudhary *et al*. (2011) in gladiolus, and Lalge *et al.* 2016) in heliconia.

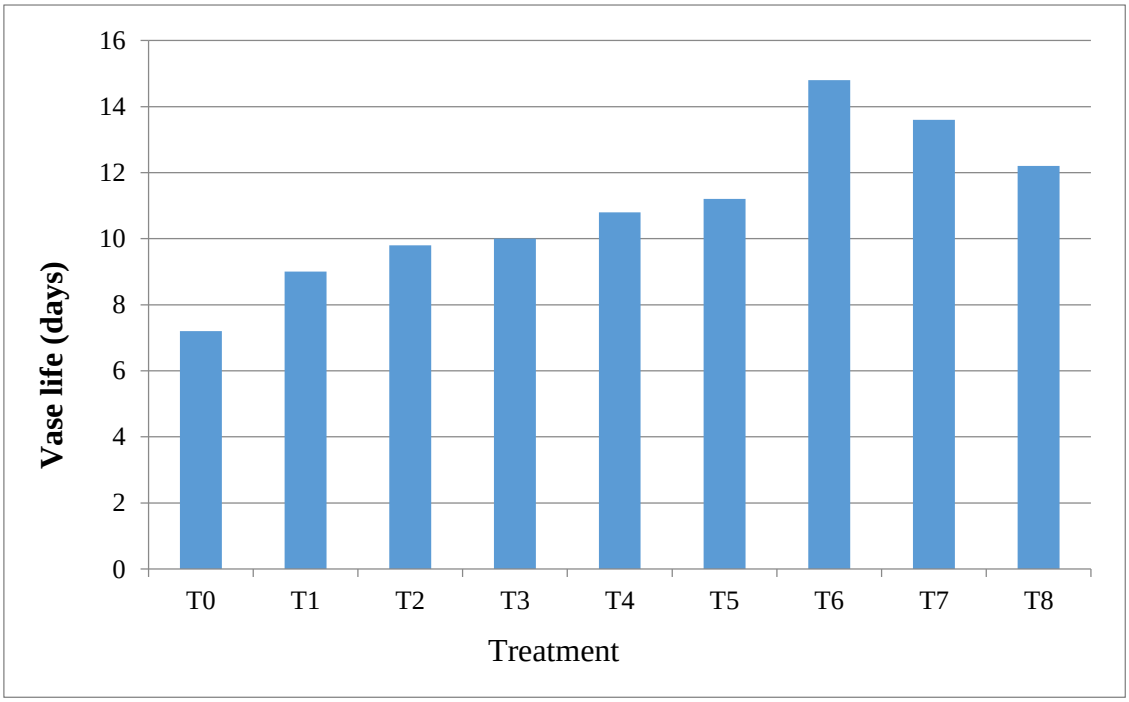
1.26 Vase life (Gerbera and Gladiolus)



T_0(Tap water) , T_1(0.4 ppm 1-MCP + 4% sucrose),T_2(50 ppm salicylic acid + 4% sucrose),T_3(100 ppm salicylic acid + 4% sucrose),T_4(0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_5(0.4 ppm 1-MCP + 100 ppm salicylic acid + 4% sucrose), T_6(50 ppm AgNO3 + 50 ppm citric acid + 0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_7(100 ppm AgNO3 + 100 ppm citric acid + 0.4 ppm 1-MCP) + 100 ppm salicylic acid + 4% sucrose), and T_8(1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar)

Figure 3: Effect of preservatives on vase life of gerbera

The vase life by cut flower showed that vase life was the maximum in the treatment (T_6) both of gerbera and gladiolus. The maximum vase life 15.8 days and 14.8 days was recorded in treatment(T_6) in case of gerbera and gladiolus. Vase life 14.6 days and 13.6 days was observed in treatment (T_7) both of the flowers. Vase life 12.8 days and 12.2 days were observed incase of conventional treatment (T_8). On the other hand, the minimum vase life was recorded in control treatment which was 8 days and 7.2 days for gerbera and gladiolus respectively. For this, T_6, T_7 and T_8 treatment are significant both of gerbera and gladiolus. But T_2(10.20 days) and T_3(10.60 days) are nonsignificant for gerbera, also nonsignificant between T_2(9.80days) and T_3(10days).



T_0(Tap water) , T_1(0.4 ppm 1-MCP + 4% sucrose),T_2(50 ppm salicylic acid + 4% sucrose),T_3(100 ppm salicylic acid + 4% sucrose),T_4(0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_5(0.4 ppm 1-MCP + 100 ppm salicylic acid + 4% sucrose), T_6(50 ppm AgNO3 + 50 ppm citric acid + 0.4 ppm 1-MCP + 50 ppm salicylic acid + 4% sucrose), T_7(100 ppm AgNO3 + 100 ppm citric acid + 0.4 ppm 1-MCP) + 100 ppm salicylic acid + 4% sucrose), and T_8(1L Warm water + ¼ tea spoon household bleach + 10 ml citric acid + ½ spoon sugar)

Figure 4: Effect of preservatives on vase life of gladiolus

Vase life was influenced by different chemical preservatives in combination. In vase solution, different types of microorganisms like bacteria, fungus, molds and yeasts grow well. These are harmful and make vascular blockage of xylem bundle that prevent water absorption. Ethylene and other toxins are produced by organisms those are responsible for flower senescence acceleration and reduction of vase life. In addition of germicide as $AgNO_3$ in vase solution can check the growth of microbes. 1- MCP is

used as ethylene gas inhibitor which helps to reduce the ethylene gas production. Thus it delays in flower senescence and hastens to the vase life of flowers. Salicylic acid used in vase solution increases to the water absorption quality of the flowers. However, the result showed that there was positive effect of using chemical preservatives in combination with vase solution of cut flowers.

It was evident that sugar, 1-MCP, salicylic acid, $AgNO_3$ and citric acid used in vase solution hasten the vase life of cut flowers. This improvement in vase life by using $AgNO_3$ may probably due to the anti-ethylene effect of silver applied as $AgNO_3$. The findings of this investigation confirm the observations of earlier workers, Abadi *et al.* (2013) in gerbera and Selvaraj *et al. (*2014) in tuberose. (Plate: 2 and Plate: 3)

Treatment	9th Day	15th Day
T_0		End of the vase life
T_1		End of the vase life
T_2		End of the vase life

Plate 2: Vase condition of Gerbera at 9th days and 15th days after preservation

Treatment	9th Day	15th Day
T_3		End of the vase life
T_4		End of the vase life
T_5		End of the vase life

Plate 2: Vase condition of Gerbera at 9th days and 15th days after preservation

Treatment	9th Day	15th Day
T_6		
T_7		
T_8		End of the vase life

Plate 2: Vase condition of Gerbera at 9th days and 15th days after preservation

Treatment	9th Day	15th Day
T_0	End of the vase life	
T_1		End of the vase life
T_2		End of the vase life

Plate 3: Vase condition of Gladiolus at 9th days and 15th days after preservation

Treatment	9th Day	15th Day
T_3		End of the vase life
T_4		End of the vase life
T_5		

Plate 3: Vase condition of Gladiolus at 9th days and 15th days after preservation

Treatment	9th Day	15th Day
T_6		
T_7		
T_8		End of the vase life

Plate 3: Vase condition of Gladiolus at 9th days and 15th days after preservation

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was occurred in at the Horticulture and Postharvest Laboratory of Sher-e-Bangla Agricultural University, Sher-e- Bangla Nagar, Dhaka during the time from January to February, 2019 at room condition to study the postharvest physiology of gladiolus and tuberose and to find out the effective treatment that can increase their postharvest life. The experiment was laid out in Complete Randomize Design (CRD) with single factor. There were altogether 18 treatment combinations with five replications in this experiment.

Cut flowers as gerbera and gladiolus were kept in solutions containing different chemical preservatives as well as tap water (control), 0.4ppm 1- MCP 4%Sucrose 50 ppm Salicylic Acid + 4% sucrose , 0.4 ppm (1- MCP) + 50ppm Salicylic Acid + 4% Sucrose, 0.4ppm (1- MCP)+ 100ppm Salicylic Acid + 4% Sucrose , 50ppm $AgNO_3$ + 50ppm Citric Acid + 0.c , 100ppm $AgNO_3$ + 100ppm Citric Acid + 0.4 0.4ppm 1-MCP + 100ppm Salicylic Acid + 4% Sucrose , 1L Warm water + 1/4Tea spoon Bleach +10ml Citric Acid +1/2 Spoon Sugar . pH range of each solution was maintained to 4.5 -5.0 Citric acid was used for maintaining the pH level .

Data was collected on solution uptake, number of petal fall, number of petal discoloration, vase life for gerbera and solution uptake, number of days taken for opening of basal florets, number of florets open at senescence of basal florets, vase life for gladiolus.

15.8 days and 14.8 days was the highest vase life of gerbera and gladiolus in treatment (T_6) compared to 8.0 days and 7,2 days in control. Treatment with T_7 provided vase life of 14.6 days and 13.6 days in gerbera and gladiolus respectively. Treatment with T_8 vase solution showed the vase life of 12.8 days and 12.2 days for gerbera and gladiolus.

The highest amount of solution uptake was done by treatment T_6 in both of gerbera and gladiolus compared to control. Then the solution uptake was 58.4 ml and 102.2 ml for gerbera and gladiolus in the treatment of T_7 vase solution. 47 ml and 96.4 ml was the solution uptake for gerbera and gladiolus in case of conventional treatment T_8.

Days taken for petal discoloration was recorded and 16.8 days was the highest of gerbera in treatment T_6 compared to the control in which was 9.2 days. Then, 15.2 days

and 14.2 days was taken for petal discoloration in treatment T_7 and conventional treatment

Days taken for petal fall was observed and 17.6 days was the highest of gerbera in treatment T_6 compared to the control in which was 10.2 days. Therefore, 16.20 days and 15 days was taken for petal fall in treatment T_7 and conventional treatmentT_8.

The lowest days was taken for opening of basal florets in case of treatment T_6 vase solution and 2.2 days was recorded for gladiolus compared to control treatment in which the highest required days was 4.8. Then 2.4 days and 3.2 days was taken for opening of basal florets in the treatment T_7 and the conventional treatment T_8.

The highest number of florets open at senescence of basal floret was recorded and the value was 6.8 in treatment T_6 for gladiolus compared to the control in which the value was 2.2. 6.2 florets opened incase of treatment T_7 and 5.8 florets opened in conventional treatment T_8 of gladiolus.

A significant difference was identified among the treatments with respect to majority of the observed parameters. The result of the experiment noticed that 1-MCP and combination of sucrose, salicylic acid, $AgNO_3$, citric acid had significant influence on all the parameters studied.

The following conclusions may be drawn by analyzing the results accomplished in the present studies –

- 1-MCP, $AgNO_3$, the commercial chemical preservatives increase the vase life and quality of cut gerbera and gladiolus. Combined response of 1-MCP, $AgNO_3$, Salicylic acid, Citric acid and Sucrose provided the best result in both of cut gerbera and gladiolus.
- These chemical flower preservatives are not available in Bangladesh, conventional vase solution formed in combination with 1L Warm water + 1/4Tea spoon Bleach +10ml Citric Acid +1/2 Spoon Sugar can be used as a substitute of those chemical preservatives to increase shelf life of cut gerbera and gladiolus .

REFERENCES

Aarts, J.F.T., (1957). Over de houndbaarheid van Snijbloimen (on keepability of cut flowers*). Meded Land bouwhogeschoot*. **57**: 1-6.

Abadi M., Moghadam A. and Abdossi, V. (2013). The affected post-harvest life of gerbera cut flowers by the application of silver nitrate, silver thiosulphate and nano silver. *Int. Res. J. of Appl. and Basic sci.* **4**(4): 806-809.

Abdul khader, H. and Rogers, M.N., (1986). Postharvest treatments of Gerbera jamesonii. *Acta Hortic*. **181**: 169-176.

Akbar, A.M., Naveed, F., Shakeel, F. and Amin, S. (2001). Effect of some chemicals on keeping quality and vase life of tuberose (Polianthes tuberosa l.) cut flowers. *J. of Res. (Science).* **12**(l): 01-07.

Al-Humaid, A. I. (2004). Effect of glucose and biocides on vase-life and quality of cut gladiolus spikes. *Acta Hortic*. 682: v International Postharvest Symposium.

Anserwadekar, K.W. and Patil, V.K. (1986). Vase life studies of Gladiolus (Gladiolus grandiflore) cv. H.B. Pitt. *Acta Hortic*. **181**: 279 - 283.

Awad, A.R.E., Meawad, A., Dawh, A.K. and El-Saka. (1986). Cut flower longevity as affected by chemical pretreatment. *J. Ornam. Hortic.* **181**: 177-193.

Bakhsh, A., Khan, M.A., Ayyub, C.M., Shah, M.A. and Afzal, M. (1999). Effect of various chemicals on vase life and quality of cut Tuberose flowers. Pakistan *J. of Biol. Sci.* **2**(3): 914-916.

Barendse, L. (1981). The cause of stem damage to gerberas. Oorzaken Van Steelbesc hadeging gerbera *vakblad voor de bloemisterji*. **36**(22): 29.

Bhattacharjee, S.K. (1999). Post-harvest biology and technology of cut flowers. *Adv. in Hort. Fores*. **3**:117-148.

Bhattacharjee, S.K. (1999). Postharvest management of cut flower, cut foliages and post production management. Ant of potted plant. *J. Ornam. Hort.* **2**(1):32-39.

Burzo, I., Amariutei and Cracium, C. (1992). Studies on the physiological, biochemical and ultrastructural changes in gerbera flowers held in water and in preservative solution. *Seria B. Hort.,* **35**(1): 103-114.

Celikel, F.G., L.L. Dodge, and M.S. Reid. (2002). Efficacy of 1-MCP (1-methylcyclopropene) and Promalin for extending the post-harvest life of oriental lilies (Lilium · 'Mona Lisa' and 'Stargazer'). *Sci. Hort.* **93**:149–155.

Chikkasubbanna, V. and Sharada, R. (2002). Effect of floral preservatives on the longevity of cut carnations. *Crop Res*. **23**(2): 357-361.

Chikkasubbanna, V. and Yogitha, N. 2002). Effect of chemical preservatives on the postharvest longevity of cut rose cvs. Cream Prophyta and Sacha. *Crop Res.* **24**(1): 49-52.

Chong, G.Y., Lee, J.S. and Kim,Y.R.(1988). Effects of silver nitrate and silver thiosulphate on the vase life and senescence of carnation flowers. *J. Korean. Soc. Hort. Sci*. **21**: 176-184.

Choudhary, M. L. and Prasad, K. V. (2000). Protected cultivation of ornamental crops. An insight. *Indian Hortic.* **45**(1): 49-53.

Dasgupta, D. (2006). Effect of pulsing and chemicals on postharvest life of gerbera (Gerbera jamesonii, Bolus). M.Sc. Thesis, University of Agricultural Sciences, Dharwad, Karnataka, India.

Donoghue -E.M., Somerfield-S. D. and Heyes- J. A. (2002). Vase solutions containing sucrose result in changes to cell walls of sandersonia (Sandersonia aurantiaca) flowers. *Elsevier Science*. **26**(3): 285-294.

Doorn, W.G.V., Witte, Y .De and Perik, R. R. J. (1990). Effect of antimicrobial compounds on the number of bacteria in stems of cut rose. *J. Appl. Bacteriol,* **68**:117-112.

Doorn, W.G.V., Witte, Y. De and Perik, R. R. J., (1988). Effect of ethylene activity in relation to vase life of gerbera. *Plant Growth Regul*. **50**(2): 117-112.

Durkin, D. J. Kue., R. H. (1966). Vascular blockage and senescence of rose flowers. *Proc. Amer. Soc. Hort. Sci.* **89**: 683-688.

Elgimabi, M.N. Ahmed, O.K. (2009). Effects of Bactericides and Sucrose-pulsing on Vase Life of Rose Cut Flowers (Rosa hybirida*). Bot. Res. Intl*. **2**(3): 164-168.

Ezhilmathi, K., Singh V.P., Arora A. and Sairam R.K. (2007). Effect of 5sulfosalicylic acid on antioxidant activity in relation to vase life of Gladiolus cut flowers. *Plant Growth Regul.* **51**(2): 99-100.

Farnham D.S, Barr C, Halevy A.H. (1972) The value of using chemical solution for carnation conditioning and bud opening. *Flor. Rev.*; **150**(3980): 17-18, 52-54.

Garibaldi, E.A. and Deambrogio, F. (1989). Preserving Cut gladiolus flowers. *Colture protette.* **18**(6): 33-35.

Gowda, J.V.N and Gowda, V.N. (1990). Effect of calcium aluminum and sucrose on vase life of gladiolus. *Crop Res*. *Hiser.* **3**(l): 105-106.

Gowda, J.V.N and Gowda, V.N. (1990). Effect of calcium aluminum and sucrose on vase life of gladiolus. *Crop. Res.Hisar*. **3**(l): 105-106.

Halevy, A.H. and Kofranek, A.M. (1984). Evaluation of Lisianthus as a new flower crop. *Hort. Sci*. **19**: 845 — 847.

Halevy, A.H. and Mayak, S.S. (1979). Senescence and pos harvest physiology of cut flowers. *Part I Hort. Rev*. **3**: 204 — 236.

Halvey, A.H., Mayak, S. (1981). Senescence and postharvest physiology of cut flowers. Part II: (J. Janick. Ed*), Hortic. Rev.* **3**: 59- 143.

Hamilton, S. (1976). A history of the garden gladiolus. Garden. **101**: 428- 424

Hassan F.A.S., Ali E. (2014). Physiological response of gladiolus flowers to anti-ethylene treatment and their relation to senescence. *Int. J. of Adv. Res.* **2**(10): 88-199.

Hassanpour,A.M., Karimi A.M. and Zakizadeh H. (2013). 1-MCP improves the postharvest quality of cut spray carnation (Dianthus caryophyllus L.) 'Optima' flowers. *Hort. Environ. Biotechnol*. **54**: 58–62.

Huang, K.L. and Chen, W. S. (2002). BA and sucrose increase vase life of cut Eustoma flowers. *Hort Science.* **37**(3): 547-549.

Ichimura, K., Kawabata, Y., Kishimoto, M., Goto, R and yamada, K. (2002). Variation with the cultivar in the vase life of cut rose flowers. *Bull. Natl. Inst. Flor. Sci*. **2**: 9.

Ichimura, K., Kojima, K. and Goto, R. (1999). Effects of temperature, 8-hydroxyquinoline sulphate and sucrose on the vase life of cut rose flowers. *Postharv. Biol. Technol*. **15**: 33-40.

Islam, N., Patil, G.G. and Gislerod, H.R. (2003). Effect of pre. and postharvest conditions on vase life of Eustoma grandiflorum Raf, Shinn. Europ. J. *Hort. sci.* **68**(6): 272 - 278.

Jalili Marandi, R., Hassani, A. and Hanafi, S. (2011). Application of *Carum copticum* and *Satureja hortensis* essential oils and salicylic acid and silver thiosulphate in increasing the vase life of cut rose flowers. *J. Med. Plants Res*. **5**: 5034–5038

Kader, A. A. (1992). Postharvest biology and technology: An overview. Postharvest technology of horticultural crops. Second Edition, University of California, Division of Agriculture and Natural Resourses, Publication 33 1 1, pp. 15 - 20.

Kawabata, S.Y. and Sakiyama, R. (1999). The regulation of anthocyanin biosynthesis in Eustoma grandiflorum under low light conditions. *J. Japan. Soc. Hortic. Sci*. **68**: 519-526.

Ketsa, S., Piyasaengthong, Y. and Parthuangwong, S. (1995). Mode of action of $AgNO_3$ in maximizing vase-life of Dendrobium pompodour flowers. *Postharvest Biol. Technol*. **5**: 109-117

Khan, W., Prithviraj, B and Smith, D.L (2003). Photosynthetic responses of corn and soybean to foliar application of salicylates. *J. Plant Physiol*. **160**: 485–492.

Knee, M. (2000). Selection of biocides for use in floral preservatives. *Postharvest Biol. Technol*. **18**: 227 -234.

Lalge, B., Rodge R. and Rangwala A. (2016). Effect of different chemicals on vase life of Heliconia cv. Golden Torch. *Asian J. of Multidisciplinary Studies*. **4**(3): 71-72.

Lazar E.E, Wills R.B.H, Ho B.T, Harris A.M and Spohr L.J. (2008). Antifungal effect of gaseous nitric oxide on mycelium growth, sporulation and spore germination of the postharvest horticulture pathogens, Aspergillus niger, Monilinia fructicola and Penicillium italicum. *Letters in Applied Microbiology*. **46**: 688-692.

Lineberger, R.D. and Steponkus, P.L. (1976). Identification and localization of vascular occlusions in cut roses. *J. Amer. Hort. Sci*. **94:** 223 - 226.

Marousky, F.J. (1968). Physiological role of 8-hydroxyquinoline sulphate and sucrose in extending the vase life and improving quality Of cut gladiolus. Proc. Fla State, *Horti Soc*. **81**: 414.

Masterlenz, J.W. (1953). Conditioning flowers after holding at 320 F. N. Y. *Stea Flow Grow Bul*. **94**: 22-27.

Mayak, S.S., Halevy, A.H. and Kofranek, A.M. (1973): Improvement of opening of cut gladioli flowers by pretreatment with high sugar concentrations. *Sci. Hortic*. **1** : 357-365.

Meeteren, U.V. (1977). Dropping of gerbera flowers. *Vakblad voor de Bloemisterji*. **32**(4): 46-47.

Meeteren, U.V. (1978). Water relations and keeping quality of cut gerbera flowers I. The cause of stem break. *Sci. Hortic*. **5**(1): 65- 74.

Meeteren, U.V. (1980). Water relations and keeping quality of cut gerbera flowers. Role of pressure potential. *Sci. Horict*. **72**(2): 283-292.

Merwe, J.J., Swardt, G.H. and Burger, L. (1986). The effect of sucrose uptake from a vase medium on the starch metabolism of senescing gladiolus inflorescence. *South African J. of Bot*. **52**(6): 541-545.

Nagarrj, G.S, Gopinath, R. and Gowda, J.V.N. (2000). Effect of pulsing with sucrose and silver nitrate on vase life of gerbera *(Gerbera jamesonii). Mysore J. Agril. Sci*. **34**(2): 102-104.

Nair, S.A., Sivasamy, N., Attri, B.L. and Sharma, T. V. R. S. (2000). Effect of natural and chemical floral preservatives on vase life of cut gerbera – a comparative study. *Indian Coconut J*. **31**(3): 29-31.

Nair, S.A., V.T. Singh, and V.R.S. Sharma. 2003. Effect of chemical preservatives on enhancing vase-life of gerbera flowers. *J. Trop. Agril*. **41**: 56–58

Nowak, J and Rudnicki, R. M. (1984). Cold storage of gladiolus cut spikes. Prace-InstytutuSadownictwa-i-kwiacfarstwa-w-Skterniewicach-Rosliny-Ozdobne. **9**: 67 - 72.

Nowak, J. (1981). Regulation of bud opening, storage period, vase-life and senescence of cut flowers. I. The effect of silver complexes and sucrose on longevity of cut gerbera inflorescences stored for different periods of time. *Res. Inst. Pomol. Floricult. Annu*. **2**: 3–10.

Nowak, J. (1989). Pulsing and use of floral preservative to improve keeping quality of cut gerbera inflorescence after dry shipment. *Int. J. Agri. Biol*. **7**: 1.

Nowak, J. and Rudnicki R.M. (1990). Postharvest handling and storage of cut flowers, *Florist Press.* **2**: 27-36.

Panse, U. G. and Sukhatme, P. V. (1967). Statistical Methods for Agricultural Workers. 2nd ed., ICAR, New Delhi Rogers, M. N. 1973. A historical and critical review of postharvest physiology research on cut flowers. *Hortic. Sci*. **8**: 189-194.

Patil, M.T. and Singh, B. R. (1995). Postharvest studies in rose. *J.Maharashtra Agri.Uni*.**20**: 24-125.

Popova, L., Pancheva, T and Uzunova, A (1997). Salicylic acid: properties, biosynthesis and physiological role. Bulg. *J. Plant Physiol*. **23**: 85–93.

Reddy,B-S. and Singh,-K. (1996). Effects of aluminum sulphate and sucrose on vase life of tuberose. *J. Maharashtra Agril. Univ*. **21**(2): 201-203.

Reid, J. (1996). Postharvest handling recommendations for cut tuberose. *Perishables Handling Newsletter.* **88**: 21-22.

Rogers, M. N. (1962). Sell flowers that last. *Flor. Rev*. 131(3385): 29-30, 71-73.

Rogers, M. N. (1973). A historical and critical review of postharvest physiology research on cut flowers. *Hort Science*. **8**: 189-194.

Salunkhe, D.K., Bhat, N.R. and Desai, B.B. (1990). Post-Harvest Biotechnology of Flowers and Ornamental Plants. *Springer-Verlag, Berlin*. pp. 349412

Sathyanarayana, R.B., Singh, K., Singh, A. and Saini, A. (1996). Advances in Agricultural Research in India. *Indian Hort*. **4**: 39-45.

Scariot, V., R. Paradisob, H. Rogersc, and S. De Pascaleb. (2014). Ethylene control in cut flowers: Classical and innovative approaches. *Postharvest Biol. Technol.* **97**: 83–92

Selvaraj, K.S.V., Bharathi, A. and Swaminathan V. Effect of sucrose and different chemical combinations to improve post-harvest keeping in tuberose spikes. *Int. J. Proc. & Post harvest Technol*. **5**(1): 16-19.

Shirasu, K., Nakajima, A., Rajshekar, K., Dixon, R.A and Lamb, C (1997). Salicylic acid potentiates an agonist-dependent gain control that amplifies pathogen signal in the activation of defense mechanism. *Plant Cell.* **9**: 261–270.

Shobha, K. S. and WDA, J. V. N (1993). Effect of chemical pretreatment on the vase life of rose cv. 'Queen Elizabeth'. *Indian Rose Annual*.**11**: 69-71.

Singh, B. and Sharma, S. (2001). The postharvest life of pulsed gladiolus spikes: The effect of preservative solutions. *Indian J. of Botan. Sci*. **83**: 26-29.

Song, L. R., Shieh, M. and Lai, S. F. (2001). Effect of exogenous ethylene and ethylene inhibitor on flower physiology of cut rose Grand gala and Medal. *J. of the Chinese Soc. for Hortic. Sci*. **47**: 281-290.

Steinitz, B. (1982). Role of sucrose in stabilization of cut gerbera flower stalks. *Garten bouwissen schaft*. **47**(2): 77-81.

Steinitz, B. (1983). The influence of sucrose and silver on dry weight, fibre, lignin contents and stability of cut gerbera cut stalks. *Garden bouwissin Schaft.* **48**(3): 85-87.

Suma, C. (2000). Floral preservatives to extend vase life of cut alstroemeria flowers. M.Sc. Thesis. University of Agricultural Sciences, Bangalore.

Suneetha, S. (1994). Effect of planting dates and floral preservatives on spike qualities of gladiolus. M.Sc. Thesis, KAU.

Tickner, M.A.H. (1942). The care of cut flowers. *J. Roy. Hort. Soc.* **67**(11): 373-380; (12): 392-396.

Torre, S. and Fjeld, T. (2001). Water loss and postharvest characteristics of cut roses grown at high or solutions on tuberose (Polianthes tuberose L.) cut flower vase life. *Hortic. Sci***. 9**: 39-45.

Van Meeteren, U., Van Gelder H. and Van Ieperen W. (2000). Reconsideration of the use of deionized water as vase water in postharvest experiments on cut flowers. Postharvest experiments on cut flowers. *Postharv. Biol. Technol*. **18**: 169-181.

Yldrm, T.B., Hatipoglu, A., zager, B. and Gulgun, B. (1995). Research on the effect of the preservative chemicals used for extending the vase life of some cut flowers. *Ege universitesi Ziraat Fakultesi Dergisi*. **32**(1): 175-182.

APPENDICES

APPENDIX I

Appendix I: Analysis of variance of solution uptake, days taken for discoloration of petal, days taken for petal fall and vase life of gerbera as influenced by different preservatives.

Source of variation	Degree of freedom	Mean square			
		Solution uptake (ml)	Days taken for discoloration of petal	Days taken for petal fall	Vase life (days)
Different preservatives	8	1021.84**	29.9000**	27.4556**	31.1222**
Error	36	0.99	0.5222	0.4889	0.4889

**: Significant at 0.01 level of probability

Appendix II: Analysis of variance of solution uptake, number of days taken for opening of basal petal, number of floret open at senescence of basal floret and vase life of gerbera as influenced by different preservatives.

Source of variation	Degree of freedom	Mean square			
		Solution uptake (ml)	Number of days taken for opening of basal petal	Number of floret open at senescence of basal floret	Vase life (days)
Different preservatives	8	2046.15**	3.05000**	10.8389**	27.2389**
Error	36	1.28	0.23333	0.3667	0.3333

**: Significant at 0.01 level of probability