INFLUENCE OF PRESERVATIVE SOLUTIONS ON VASE LIFE OF THREE FLOWER SPECIES

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INFLUENCE OF PRESERVATIVE SOLUTIONS ON VASE LIFE OF THREE FLOWER SPECIES

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CERTIFICATE

*This is to certify that thesis entitled, "**INFLUENCE OF PRESERVATIVE SOLUTIONS ON VASE LIFE OF THREE FLOWER SPECIES**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OSCIENCE (MS) in HORTICULTURE**, embodies the result of a piece of bona-fide research work carried out by **Mst. Mahmuda Dastagir**, **Registration no.14-05896** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged

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INFLUENCE OF PRESERVATIVE SOLUTIONS ON VASE LIFE OF THREE FLOWER SPECIES

ABSTRACT

Three experiments were conducted in the Horticultural Biotechnology and Stress Management Lab of Sher-e-Bangla Agricultural University, Dhaka to investigate the effect of different preservative solutions on vase life of Chrysanthemum, Aster and Button flower. The experiment was consisted of eight preservative solutions *viz:* T_0 : Control (tap water), T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid,followed Completely Randomized Design with three replications. Experimental results revealed that all the treatment influenced on vase life of three flower species. The maximum vase life of Chrysanthemum flower was found (9.33 days) in T_7 treatment whereas the lowest number of days (4.33) was recorded in T_0 treatment. Considering effect of preservative solutions on Aster flower, the maximum vase life (8 days) was observed in T_7 treatment and the minimum (3 days) was noticed in T_0 treatment. Regarding the experiment on Button flower, similar results were also observed where the highest vase life (10.33 days) was recorded in T_7 whereas the lowest number of days (4.33) was observed in T_0 treatment. Therefore, the preservative solution under T_7 treatment can be suggested for better vase life of the three flower species.

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ABBREVIATIONS

Full word	Abbreviations	Full word	Abbreviations
Agriculture	Agric.	Milliliter	mL
Agro-Ecological Zone	AEZ	Milliequivalents	Meqs
And others	et al.	Triple super phosphate	TSP
Applied	App.	Milligram(s)	mg
Bangladesh Bureau of Statistics	BBS	Millimeter	mm
Biology	Biol.	Mean sea level	MSL
Biotechnology	Biotechnol.	Metric ton	MT
Botany	Bot.	North	N
Centimeter	Cm	Nutrition	Nutr.
Cultivar	Cv.	Regulation	Regul.
Degree Celsius	°C	Research and Resource	Res.
Department	Dept.	Review	Rev.
Development	Dev.	Science	Sci.
Dry Flowables	DF	Silver nitrate	$AgNO_3$
East	E	Soil plant analysis development	SPAD
Editors	Eds.	Soil Resource Development Institute	SRDI
Emulsifiable concentrate	EC	Technology	Technol.
Entomology	Entomol.	Tropical	Trop.
Environments	Environ.	Thailand	Thai.
Food and Agriculture Organization	FAO	United Kingdom	U.K.
Gram	g	University	Univ.
Horticulture	Hort.	United States of America	USA
International	Intl.	Wettable powder	WP
Journal	J.	Serial	Sl.
Kilogram	kg	Percentage	%
Least Significant Difference	LSD	Microgram	µ
Liter	L	Number	No.

CHAPTER I

INTRODUCTION

Bangladesh is the land of flowers. The history of floriculture in Bangladesh maybe old but flower business is not older than a decade. Floriculture was brought to light in late 70's by some innovative farmers who took up Tuberose (the popular flower at that time) for small scale production. This kick start step acted as the foundation on which large scale commercial production of flower in Bangladesh started in Jikkargacha upazilla of Jashore district in the mid 80's. Afterward it was extended to Jashore sadar Sharsha and Chowgachha upazilla as well as Kushtia, Chuadanga, and Satkhira districts. Within a short period of time Jashore, Savar, Chuagdanga, Mymensingh, and Gazipur turned to be a major flower production belt of Bangladesh. With the increasing demand for flowers and ornamental, the floriculture industry had been gaining popularity among the farmers as it gives 3-5 times and 1.5-2 times more profit from rice and vegetable production, respectively. At present 10000 hectares of land is under flower cultivation where approximately 5000 resilent farmers are actively growing flowers and foliage in the country with 150000 people directly or indirectly involved in it as their sole livelihood. Different varieties including Marigold, Tuberose, Rose, Gladiolus, Gerbera, Button flower and Chrysanthemum are grown commercially. Flowers growers and traders make huge money every year in February, a month that sees huge sale of flowers as people celebrate three major events-Pohela Falgun (spring festival), Valentine's day, and International Mother Language Day. About 4000 retail shops are available in the country of which 40% is present in Dhaka, 25% in Sylhet and Chittagong and the rest 10% in other districts with wholesale flower business transaction of $16000 everyday (Mohiuddin, 2016). Among different grown commercially cut flowers the popularity of chrysanthemum, Aster and Button flower as cut flowers is increasing day by day in Bangladesh due to their long vase life and beautiful colours.

Chrysanthemum (*Dendrathema grandiflora* L.) is known as queen of flowers (Sajid *et al*., 2018). Chrysanthemum flowers are herbaceous perennial plants or subshrubs. They have alternately arranged leaves divided into leaflets with toothed or occasionally smooth edges. The compound inflorescence is an array of several flower heads, or sometimes a solitary head. The head has a base covered in layers of phyllaries. The simple row of ray florets is white, yellow and red.

Aster is a genus of perennial flowering plants in the family Asteraceae. Many species and a variety of hybrids and varieties are gaining fast popularity in Bangladesh because of its easy cultural practices, diversity of colours and varied uses.

Chrysocephalum apiculatum ramosissimum (Yellow button flower), an attractive prostrate groundcover producing small, yellow, button like flowers from Spring to late Autumn. Since it has delicate flowers, sellers and consumers show their keen interest which necessitates improvement of its post harvest life.

Although growing cut flower benefit the grower but there exist some serious problems such as poor extension and consultancy services, lack of knowledge and infrastructure of post-harvest management, lack of quality certification of flowers and government support is very limited (Rakibuzzaman *et al*., 2018).

Vase-life is a yardstick for the longevity of cut flowers and is an important target for improving flower characteristics, whether by chemical treatment or plant breeding (Yamada *et al.* 2003). Short postharvest vase life is one of the most important problems on the cut flowers. The maintenance of vase life is an important quality attribute in these economically significant cut flowers. A suitable method for vase life extension, which easy to use, natural, safe and inexpensive compounds is always crucial in this respect for large-scale applications. Vase life of cut flowers is mainly affected by two main factors, namely ethylene which accelerates the senescence of many flowers and microorganisms which cause vascular blockage and thus reduce the amount of water uptake, consequently the vase life of cut flowers could be reduced (Zencirkiran, 2010). The water balance is also a major factor determining the quality and longevity of cut flowers. It is influenced by water uptake and transpiration and balance between two mentioned processes (Da Silva, 2003).

Using vase preservatives in vase solutions is one of the most common methods for prolonging cut flowers' vase life. The postharvest life of flowers is strongly dependent on the carbohydrate status and the acceptable amount of metabolic sugars is factors that affect the rate of senescence. Keeping the flower in vase solutions containing sucrose has been shown to extend their vase-life. Han (2003) found that addition of sugar to vase solution improved the intensity of the petal color but did not improve bud opening, longevity, or size of non-cold-stored Oriental Lily cv. Stargazer cut flower harvested at the commercial marketing stage. However, addition of sugar

to the vase solution of defoliated stems not only restored the color on the petals but increased the size of the open flowers (Han, 2003). The effects of senescence can be reduced by inhibitors of ethylene biosynthesis and increase enzyme antioxidant activity (Khan *et al*., 2003; El-Tayeb*et al*., 2006; Shi and Zhu, 2008; Joseph *et al*., 2010). Salicylic Acid (SA), is a well known phenol that can prevent 1 aminocyclopropone-1-carboxylic acid-oxidase activity that is the direct precursor of ethylene and decrease Reactive Oxygen Species (ROS) with increase enzyme antioxidant activity (Ansari and Misra, 2007; Mba *et al*., 2007; Mahdavian *et al*., 2007; Canakci, 2008). Ethylene production of cut Gerbera flowers increased with flower senescence and treatment with Salicylic Acid (SA), an ethylene produce inhibitor, extended flower longevity (Fan *et al*., 2008). Silver nitrate ($AgNO_3$) used in commercial flower preservatives solutions and mostly used as ethylene binding inhibitor. Treated with ($AgNO_3$) strikingly enhanced vase life and solution uptake in rose cut flowers (Singh and Tiwari, 2002). Darras *et al.* (2010) reported that, treated with 20 or 40 mg L^{-1} $AgNO_3$ for 24h extended vase life by 1.6 and 1.9 days, respectively, compared to the control. Furthermore, treatment with germicides, such as silver nitrate (Ohkawa *et al*., 1999) inhibited bacterial proliferation and maintained the hydraulic conductance of stem. Citric acid (CA) is used to adjust water pH and control the growth of microorganisms. CA is a widespread organic acid in the plant kingdom and makes a weak acid in water. CA is commercially advised for a number of cut flowers like chrysanthemum (Dole and Wilkins, 1998). Also, CA reduces the risk of vascular blockage in cut flowers through its anti-embolism trait. (Bhattacharjee *et al*., 1993).

By considering the above fact the proposed research work was undertaken to achieve the following objectives:

Objectives:

i. To investigate the effects of different preservative solutions to improve vase life of three flower species.
ii. To find out best preservative solution to extend vase life of Chrysanthemum, Aster and Button flower.

CHAPTER II

REVIEW OF LITERATURE

An attempt was made in this section to collect and study relevant information available regarding to the effect of different preservatives on vase life extension of Chrysanthemum, Aster and Button flower, to gather knowledge helpful in conducting the present piece of work.

2.1 Review related to preservative solutions

Sucrose

Sucrose has been used with germicides, because sugar treatment without germicides promotes bacterial proliferation, leading to shortening of the vase life. Large amount of soluble carbohydrates is required for flower opening as the substrate for respiration and synthetic materials as well as osmolytes. Some vase solutions including sucrose extend vase life of cut flower. Kuiper *et al.* (1995) conclude that sugar plays important roles as substrates for respiration and cell wall synthesis as in plants. 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. Halevy and Mayak (1981) carried out an experiment to study the senescence and postharvest physiology of cut flowers and reported that sucrose antagonized the effect of ABA, which promotes senescence. Sugars alone, however, tends to promote microbial growth. Hence, the combination of sugars and biocides might have extended the vase life of cut flower.

Salicylic acid

Salicylic Acid (SA), a natural plant hormone has important role in abiotic and biotic stress. Salicylic acid is qualified as a plant hormone due to its physiological and biological roles in plants (Michael, 1992). It has also been suggested as a signal transducer or messenger under stress conditions (Petridou*et al*., 2001). Salicylic acid has potential to reduce pH of water and consequently, the proliferation of bacteria was reduced (Raskin, 1992). It is reported that SA suppresses ACC synthase and ACC oxidase activities and biosynthesis of ethylene in kiwi fruit (Redman *et al*,. 2002).

Moreover, SA has been shown to restrict with the biosynthesis and/or action of ethylene in plants (Roein, 2009). Addition of SA and sucrose to vase solution of cut roses caused a significant reduction in respiration rate, alleviation of the moisture stress and improved the vase life (Senaratna*et al.,* 2000). Moreover, it has been shown that treatment with SA improved postharvest life of different cut flowers (Bleeksma and van Dorn, 2003).

$AgNO_3$

Silver nitrate ($AgNO_3$) is one of the most common forms of silver salts used in commercial flower preservatives solutions and mostly used either as ethylene binding inhibitor or antimicrobial (MohyEldeen, 2011). Increasing $AgNO_3$ strikingly enhanced vase life and solution uptake by removing bacteria and water supply in (Rose) cut flowers (Singh and Tiwari, 2002).

Citric Acid

Citric acid is a regular ingredient in many vase solution formulations that acts as a pH regulator that reduces bacterial proliferation and enhances the water conductance in xylem of cut flowers (Goszczynska and Rudnicki, 1988; van Doorn, 2010).

2.2Review related to chrysanthemum flower

Patel *et al*. (2021) carried out an investigation to observed the chemical preservation for increasing shelf life of *Chrysanthemum indicum* L. cut flower. Here, the different chemical preservative treatments consisting of sucrose, salicylic acid, citric acid, aluminum sulphate and their combination were used to increase the vase life and the petal discoloration of chrysanthemum cut flowers. It was observed that all the preservatives treatments {expect T_3 (Citric Acid (150ppm) + Aluminum sulphate (500ppm)} extend the vase life and reduced petal discoloration over the control. The result showed in containing T_2 [sugar (4%) + salicylic acid (100ppm)] andT_6 [citric acid (150ppm) + aluminum sulphate (500ppm) +7% sucrose] resulted in maximum vase life 18 days and 16 days, total transpiration water loss (gm/flower/day) 34 and 29.42,total water uptake 33.13 and 26.84 in room temperature and reduced leaf browning more than control.

Veluru *et al*. (2018) conducted a study to improve the postharvest life of chrysanthemum cut flowers using preservative solutions such as 5-sulfosalicylic acid

(5-SSA) and aluminium sulphate ($Al_2(SO_4)_3$) alone or in combination with 1.5 % sucrose. Treatments using 5-SSA (100 ppm and 150 ppm) or 200 ppm $Al_2(SO_4)_3$ along with 1.5 % sucrose showed a significant increase in vase-life, fresh weight of the cut stems, vase solution uptake, membrane stability index of the petals and leaf chlorophyll as compared to other treatments. Among different vase solutions evaluated, T_{10} (200 ppm $Al_2(SO_4)_3$ +1.5 % sucrose) gave maximum vase life of 22.3 days, followed by T_8 (5-SSA 150 ppm + 1.5 % sucrose) and T_6 (100 ppm 5-SSA+ 1.5 % sucrose) treatments with 20.85 and 19.85 days respectively as compared to 17.84 days in control. High concentrations of both the chemicals {5-SSA and $Al_2(SO4)3$} without sucrose showed toxicity symptoms.

Amin (2017) observed that distilled water was better than tap water to enhance the amount of water uptake by cut flowers.

Patel *et al.* (2016) conducted an experiment to observed the effect of chemical preservative on water relation and vase-life of *Tithonia rotundifolia* Blake Cut flower. In this study Citric acid-100ppm, Aluminium Sulphate-100ppm and 1% Sucrose were used in different combination to enhance the longevity of *Tithonia rotundifolia* Blake cut flower. Experiment result showed that, sucrose supply increase flower vase life by approaching carbohydrate starvation. 1 % sucrose solution increase the capacity of water uptake while combination of citric acid 100 ppm, aluminium sulphate 100 ppm and 1 % sucrose was proved best to maintain water balance in flower. It is also an osmotically active molecule leading to the promotion of subsequent water relation. So by application of these chemicals, blockage of vessels is prevented and ethylene levels retain resulting in prolonged fresh vase life, thus decreasing floral fading percentage.

Jain *et al.* (2014) conducted an experiment at the Division of Floriculture and Landscaping, Indian Agricultural Research Institute, New Delhi. To enhance the vase life and to reduce the foliage discoloration of chrysanthemum (Dendranthema × grandiflora Ramat.) cv. White Reagan, different floral preservative treatments consisting of cobalt chloride, salicylic acid, sodium nitro prusside, aluminium sulphate, 8- HQC and sucrose were used. Experiment was laid out in completely randomized block design with eleven treatment combinations and each treatment was replicated thrice. It was observed that maximum vase life, solution uptake, increase in

flower size and minimum foliage discoloration was observed in flowers held in preservative containing 400 ppm 8-HQC and 1.5% sucrose, which was significantly superior over all other treatments.

Kafie *et al.* (2014) investigate that the *Chrysanthemum* cut flowers were held in the vase solution containing Silver nitrate (75 ppm) + Citric acid (150 ppm) + Sucrose at (3%) was increased significant vase life (19.5 and 17.2 days, respectively).

Sharma and Srivastava (2014) conducted an experiment to investigate of the postharvest life of cut chrysanthemum cultivars in relation to chemicals, wrapping material and storage conditions and reported that Vase life and flower quality were significantly influenced by chemicals, wrapping material and storage conditions. Minimum weight loss of spikes, maximum total water absorbed, flower diameter and vase life were obtained in treatment T_2 (4% sucrose) as compared to control (Tap water).

Kabirl *et al.* (2012) carried out a study with different pH level (pH 3.0, pH 5.0 and pH 7.0) and sucrose solution (2.0 %,3.0 % and 0 %) on vase life of chrysanthemum and reported that a mixture of 3.0 % sucrose solution with low pH (3.0) was found as the best keeping solution for improving post-harvest quality and longevity of chrysanthemum.

Mashhadian *et al.* (2012) reported that the application of citric acid increased relative fresh weight of Chrysanthemum cut flowers in comparison to control.

Soad *et al*. (2011) higher weight of spikes is considered good because they may result in extending vase life compared to those showing fewer ones.

Zamani *et al.* (2011) showed that sucrose at 3 %, citric acid, malic acid and salicylic acid increasing water uptake in Chrysanthemum cut flowers.

Mousa *et al.* (2009) on *Gerbera jamesanii*cv. Dune indicated that vase life of flowers was significantly increased by addition of 6% sucrose in preservative solution. Sucrose might have enhanced the effect of cytokinin in delaying senescence of flowers and reduced the effect of ethylene thereby increasing the vase life of the flowers. The extended of vase life of cut flower (gerbera) with optimal concentrations of sucrose was due to better water relations, and also probable use of sucrose as a repairable substrate.

Jain *et al.* (2009) who reported the maximum vase life of chrysanthemum cv. Shyamal with 150 ppm citric acid +1000 ppm $Al_2(SO4)_3$ +2% sucrose.

Suresha *et al.* (2009) carried out an experiment to know the Extension of vase life of cut chrysanthemum (*Chrysamthemum moriifolium* Ramat.) flower cvs. WHITE FIZII and PEACH FIZII. Flowers were harvested when the flowers fully opened and taken to the laboratory within 24 hours after harvest. The flowers were treated with Aluminium sulphate ($Al_2(SO4)_3$) (100, 200 and 300 ppm) and Cobalt sulphate ($CoSO_4$) (0.5, 1.0 and 1.5 m M). The best concentration obtained from previous trial was treated with sucrose (2 and 4 %). Finally, the best combination obtained from combining mineral salts and sucrose was incorporated with germicide, 8- Hydroxy Quinoline Sulphate (8- HQS) at 100 and 200 ppm. Among the treatments tested, 300 ppm Al2 (SO4)3 + 4 % sucrose + 100 ppm 8- HQS had recorded maximum vase life of 25.8 days in cv. WHITE FIZII as compared to 14.8 days in control and registered better water balance (+ 8.0) in comparison to control (- 10.0). Whereas, in case of cv. PEACH FIZII, 0.2mM CoSO4 + 4 % sucrose not only showed increased vase life of 29.0 days against 19.2 days in control but also recorded positive water balance (+ 20.8) verses control (- 8.6).

Wiraatmaja *et al.* (2007) also reported that longer vase life (6.02 days over control) of chrysanthemum cut flower with 2.70% of sucrose +400 ppm of citric acid.

Yuniarti *et al.* (2007) who reported that use of holding solution containing citric acid increased the vase life of chrysanthemum cv. Cat Eye's by 9.00 days compared to control.

Luo *et al*. (2003) reported that use of sucrose in the vase solution influenced water uptake, transpiration loss of water, maintained better water relations thereby improved fresh weight of in cut carnation flowers.

Hussain *et al.* (2001) reported that sucrose in combination with citric acid or aluminium sulphate maintains endogenous levels of soluble sugars and soluble proteins which in turn provide energy as well as required osmaticum for floret development and longevity.

Park *et al*. (2000) who recorded higher fresh weight of cut chrysanthemum spikes kept in a solution containing $Al_2(SO_4)_3$ (250 ppm) and sucrose (3%).

Bhattacharjee (1999) carried out a study on postharvest management of cut flowers, cut foliage and postharvest management of potted plant and reported that the vase life of cut flowers is influenced by variety of factors like climate, variety, harvesting time, postharvest handling etc**.** A wide range of floral preservatives in the form of germicides, ethylene antagonistics and source of energy (sucrose) are in use to preserve flower quality and extending Postharvest longevity of cut flowers.

WeiMing *et al.* (1997) reported that, the vase life of chrysanthemum cut flowers was significantly increased when treated with 8-HQS +sucrose which was attributed to the inhibition of ethylene action by 8-HQS.

Awad *et al.* (1986) reported that flower stalks placed in sucrose solutions absorbed more vase solution than those placed in water (without sucrose). It might be cause that water balance improved by maintaining turgidity.

Marousky (1980) reported that addition of antimicrobial compounds to the vase solutions containing carbohydrates increase fresh weight of cut stems.

Halevy *et al.* (1978) found that citric acid was widely used to decrease the pH of water balance and reduce stem plugging citric acid showed positive effect in increasing the longevity of cut flowers.

2.3 Review related to others cut flower

Silva *et al*. (2013) indicated that most floral preservatives contain carbohydrates, germicide, ethylene inhibitors, growth regulators and some mineral compound. Carbohydrates are the main source of nutrition for cut flowers and the source of energy necessary for maintaining all biochemical and physiological processes after separation from the mother plant.

Gerailoo and Ghasemnezhad (2011) reported that a combined solution of sucrose + SA is also recommended to enhance the post-harvest attributes of cut flowers drastically.

Kazemi *et al.* (2011) who declared that salicylic acid, citric acid and ascorbic acid on flower, improve quality and floret diameter of different cut flower crops.

Shirin and Mohsen (2011) reported that, different chemical combinations with sucrose increase the post-harvest life of cut flowers and their physiological characteristics.

Tiwari *et al*. (2010) carried out two set of experiments to investigate the effect of vase solution made of different chemicals on vase-life and quality of cut flowers of gladiolus and China aster cultivars. Out of the four vase solutions applied, the treatment with 200 ppm citric acid, 200 ppm $AgNO_3$, 5% sucrose and 0.02% Tween-20 was observed to be the best followed by 200 ppm citric acid, 200ppm $CoNO_3$, 5% sucrose and 0.02% Tween-20, resulting in the longest vase-life and maximum weight gain at third day and total solution uptake. Correlation revealed that floret diameter had a strong positive correlation with loss in weight of vase solution up to ninth day, total weight loss of vase solution, floret opening per cent and vase-life in various cultivars of both crops.

Maree (2010) indicated that many cut flower preservatives have been formulated specifically to treat a specific flower or groups of flowers. This is aimed directly to control a specific problem that flowers have such as stem bending, ethylene sensitivity, yellowing, rotting and wilting.

Jowkar and Salehi (2006) reported that Citric acid lowers the pH of cell sap and prevents the blockage of xylem vessels, thereby improving water uptake and extending longevity. It promotes floral opening and maintains postharvest quality of cut flower (tuberose) spikes.

Butt (2005) suggested that variation of vase life depends on different responses to chemical compounds as well as genetic variability of flowers.

Dole (2005) reported that Preservatives contain anti-bacterial components to eliminate micro-organisms in the water as well as on stems of the flowers.

Singh *et al.* (2003) undertaken a study on the effect of holding solutions on vase life and quality of China aster cv. Shashank flowers. Holding solutions were found beneficial in increasing vase life and quality of cut flowers over the control (tap water). Maximum vase life (15.88 days) and solution uptake (40.13 ml) was recorded with 8-HQC (200 ppm) + sucrose (1%) over the control (8.42 days and 25.22 ml, respectively). Fresh weight of cut stems increased at 3rd and 6th day in vase but declined at senescence. Similar changes were recorded on dry weight also. Maximum increase in flower diameter (7.35 cm) was recorded with AgNO3 (20 ppm) + citric acid (75 ppm) + sucrose (3%) over the control (5.99 cm). Holding solution containing

8-HQC (200 ppm) + sucrose (1%) was found best in prolonging vase life of China aster cut flowers, followed by 8-HQC (200ppm) + sucrose (2%).

Pun and Ichimura (2003) reported that sugars support the fundamental process for prolonging the vase life of cut flowers, such as maintaining mitochondrial structure and functions, improving water balance by regulating transpiration, and increasing water absorption.

Singh and Tiwari (2002) reported that silver ions have a positive influence on the water uptake because of antibacterial effects and improve solution uptake.

Muhammad *et al*. (2001) indicated that several chemical preservatives, i.e. citric acid, boric acid, ascorbic acid, aluminum sulphate, cobalt sulphate, silver nitrate, 8-hydroxyquinoline sulphate, sucrose, etc. have been used in different formulations and combinations to enhance the vase life of cut flowers.

Patil and Reedy (2001) on *Solidago Canadensis* L. revealed that citric acid increased the vase life by enhancing the water uptake and maintain better water balance and fresh weight of cut flowers. The vase life of cut flowers increased from a minimum of 7.07 days in distilled water to 13.25 days in solution containing 2% sucrose and 1.00 mM citric acid.

Singh. *et al.* (2000) reported that the vase life or longevity of cut flowers depends on its water relations and the rate of senescence.

Tiwari and Singh (2000) reported that the decrease in fresh weight at petal senescence might be due to the reduced level of starch, cell wall polysaccharides, proteins and nucleic acid. Ethylene induces rapid hydrolysis of storage materials due to which heavy weight loss and senescence was noticed in flowers held in distilled water.

Abdel and Rogers (1986) in cut flowers that longevity can be increased by using a preservative solution containing an antimicrobial agent, an acidifying agent, and sucrose.

Rogers (1973) fresh weight of flower can increase if the absorption of water more than the transpiration rate.

Angel and Vignesh (2021) conducted a postharvest experiment was to maximize the vase life of gladiolus using different preservative solution in Department of

Horticulture, Faculty of Agriculture, Annamalai University. In this experiment the treatment consisted of two preservative chemicals viz., 8-hydroxy quinolone sulphate @ 150, 300, 450 ppm and silver nitrate @ 25, 50, 75 ppm along with sucrose @ 2 and 4 per cent along with control (distilled water). The results of this experiment revealed that the maximum water uptake, transpirational loss of water, water balance, fresh weight change, percentage of opened florets, floret diameter, longevity of floret, vase life was recorded in T_5 (8-HQS @ 300 ppm + sucrose 4%), when compared to control. Some parameters like optical density of vase solution, days taken for the basal floret to open in vase and the percentage of wilted florets were observed least in T_5 (8-HQS @ 300 ppm + sucrose 4%). T_5 (8-HQS @ 300 ppm + Sucrose 4%) solution was found best to extend the vase life of gladiolus.

Bayat *et al.* (2013) reported that salicylic acid (SA) and sucrose addition in vase solution of roses has significantly reduced the respiration rate, alleviated humidity and improve post-harvest life of cut roses

Abdulrahman *et al.* (2012) showed that 0.5 g/l of sucrose significantly increased time to stem bending, fresh and dry weight, percentage of change in fresh weight and total carbohydrates in snapdragon cut spike flowers.

Asrar (2012) concluded that the best combination of chemicals in the holding solution should be 200 ppm 8-HQS+ 2% sucrose as this treatment recorded the maximum useful vase life of *Antirrhinum majus*.

Khalid (2012) carried out an experiment to study the evaluation of several holding solutions for prolonging vase-life and keeping quality of cut sweet pea flowers (*Lathyrusodoratus* L.) and found that the exogenous application of sucrose supplies the cut flowers with much needed substrates for respiration, and enables cut flowers harvested at the bud stage to open, which otherwise could not occur naturally, and it acts as osmotically active molecule, thereby leading to the promotion of subsequent water relations.

Mahdi *et al*. (2012) carried out an experiment for Reconsideration in using citric acid as vase solution preservative for cut rose flowers and found that the vase life of cut flowers is influenced by variety of factors like climate, variety, harvesting time, postharvest handling, cell programmed death, ethylene induced senescence, dehydration or loss of assimilates and substrates etc. Among the above mentioned,

water relation and balance play a major role in postharvest quality and longevity of cut flowers and water stress during this period is often the reason of short vase life for cut flowers.

Dias and Patil (2003) on cut roses cv. Arjum studied the effect of various chemical preservatives such as sucrose (3%), potassium nitrate (0.05%), calcium chloride (2mM), boric acid (0.1%), citric acid (100 ppm) and tap water (control). They indicated that fresh flower weight was highest in the second day with citric acid.

Beura and Singh (2002) reported that the increase in diameter and floret opening by mineral salts such as $AgNO_3$ might be due to the fact that mineral salts increased the osmotic concentration and the pressure potential of the petal cells thus improving their water balance and quality of cut flower spikes.

Dineshbabu *et al.* (2002) in dendrobium, flowers who suggested that holding solutions containing 8-HQS and sucrose improves water consumption, fresh weight and flower freshness and reduces the respiration rate thus maintain water balance and reduced physiological loss in weight thereby extending the vase life. $AgNO_3$ @ 50 ppm + sucrose 4% was also effective in increasing vase life due to improved water status reduction in microbial growth, thereby maintaining better tissue water potential.

Xueping *et al.* (1999) who stated that the appearance of cut rose flowers was enhanced positively after treating with salicylic acid.

Serek *et al.* (1996) conducted an experiment on ethylene and the postharvest performance of miniature roses and found that the positive role of $AgNO_3$ with or without sucrose and sucrose individually on preserving the leaves in good condition by lowering the per cent of wilting and inhibiting the chlorophyll and carbohydrate degradation, Even in absence of exogenous ethylene, the life of the flowers was significantly increased by inhibiting ethylene action.

Halevy *et al.* (1978) reported that the higher TLW (Transpirational Loss of Water) by gladiolus spikes held in 8-HQS @ 300 ppm + sucrose 4% might be due to higher water uptake to avoid temporary water stress.

CHAPTER III

MATERIALS AND METHODS

Three experiments were conducted at Horticultural Biotechnology and Stress Management Lab of Sher-e-Bangla Agricultural University, Dhaka to investigate the effect of different preservatives on vase life extension of Chrysanthemum, Aster and Button flower.Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Experimental period

The experiment were conducted during the period from 1st December to 20th December for Aster flower, 25th December to 15th January for Chrysanthemum flower and 20th January to 10th February for Button flower.

3.2 Geographical location

The experiment was conducted in the Horticultural Biotechnology and Stress Management Lab in central laboratory of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh. The experimental site is geographically situated at 23°77′ N latitude and 90°33′ E longitude at an altitude of 8.6 meter above sea level (Anon., 2004). The location of the experiment site was given in Appendix-I

3.3. Laboratory condition

The temperature and relative humidity of the laboratory room were recorded daily basis during the study period with a digital thermo hygrometer (TERMO, TFA, Germany). The average minimum and maximum temperature during the study period of the culture room was 17^0C to 27^0C, respectively and the average minimum and maximum relative humidity were recorded 54% and 75%, respectively.

3.4 Experimental materials

Three type spikes of chrysanthemum, aster and button flower were selected as experimental materials.

3.5 Collection of the experimental materials

Three type spikes of chrysanthemum, aster and button flower were collected from Savar. Flower spikes were sorted into different groups (based on the size and number of florets per spike) in order to maintain uniformity in the material used for experiment.

Experiments

There were three experiments conducted with three flower species. Name of the experiments as follows-

Experiment 1: Effect of different preservative solutions on vase life of Chrysanthemum flower.

Experiment 2: Effect of different preservative solutions on vase life of Aster flower.

Experiment 3: Effect of different preservative solutions on vase life of Button flower.

Three experiments were conducted chronologically.

Firstly, experiment 1was done, then experiment 2 and finally experiment 3 was performed.

3.6 Experimental treatment

The experiment was consisted of single factor with eight treatments with three replications, were conducted to achieve the desired objectives. Same types of treatments had been used for three experiments.

Treatments

T_0 : Control(Tap water)
T_1 : 3 % sucrose
T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid
T_3: 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid
T_4 : 3 % sucrose + 100 ppm $AgNO_3$+ 100 ppm citric acid
T_5 : 3 % sucrose + 200 ppm AgNO3 + 100 ppm citric acid
T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid
T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid

3.7 Preparation of the vase solution

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

i. Preparation of control solution

No preservative was added in control solution. Tap water was used only.

ii. Preparation of sugar solution (3%)

30 g sugar was weighted and dissolved in 1 litre of distilled water to prepare 3 % sugar solution.

iii. Preparation of $AgNO_3$ solution (100 and 200 ppm)

100 mg of$AgNO_3$ was dissolved in 1 litre of distilled water to prepare 100 ppm solution of $AgNO_3$. Smilarly 200 mg of $AgNO_3$was dissolved in 1 litre of distilled water to prepare 200 ppm solution of $AgNO_3$.

iv. Preparation of salicylic acid solution (200 and 250 ppm)

200 mg of salicylic acid was dissolved in 1 litre of distilled water to prepare 200 ppm solution of salicylic acid. Similarly 250 mg of salicylic acid was dissolved in 1 litre of distilled water to prepare 250 ppm solution of salicylic acid.

v. Preparation of citric acid solution (100 ppm)

100 mg of citric acid was dissolved in 1 litre of distilled water to prepare 100 ppm solution of citric acid.

3.8 The flower vase

Glass bottle (250 ml) was used as flower vase in this experiment. 120 glass bottles were used in each 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 were open.

3.9 Placement of spikes on the flower vase

Cut flowers stems were cut at a length of 15 cm and placed in the vase solutions. Slanting cut was made to create a wider surface area for increased water absorption. Single flower was being put in one bottle for Chrysanthemum and Aster flower. Three flowers were put together in one bottle for Button flower.

3.10 Design of the experiment

The experiment was consisted of single factor with eight treatments had three replications and laid out in single factor and followed Completely Randomized Design (CRD).

3.11 Light supply

In this experiment four florescent tube lights were used in the laboratory during the experimental period for sufficient and equal distribution of light for each treatment. A lighting period of 12 hour was maintained for the flowers from 6 A.M. to 6 P.M. daily.

3.12 Collection of Data

The data were recorded on the following parameters

i. Water uptake (g/splike)
ii. Water loss (g/spike)
iii. Water uptake to water loss ratio
iv. Water balance (g)
v. Fresh weight of the flower
vi. Vase life (days)
vii. Incidence of stem rotting

3.13 Procedure of data collection

i. Water uptake (g/spike)

The difference between initial and final weights of the bottle with solution (without spike) represents the water uptake and expressed in grams.

ii. Water loss (g/spike)

The difference between the initial and final weights of bottle with solution and spike represents the loss of water and expressed in grams.

iii. Water loss to water uptake ratio

Water loss to water uptake ratio was measured using the following formula

$$\text{Water loss to water uptake ratio} = \frac{\text{Water loss (g)}}{\text{Water uptake (g)}}$$

iv. Water balance (g)

Water balance was measured using the following formula

Water balance= Water uptake - water loss

v. Fresh weight of the flower (gram)

Fresh weight of the flower was measured using the following formula

Fresh weight of the flower = (Weight of bottle + solution+ flower) - (Weight of bottle + solution)

vi. Vase life (days)

When the petals dropped and lost its original color.

vii. Incidence of stem rotting

Slimy substance will be present and softening of stem will be occurred.

3.14 Data analysis

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program name Statistics 10 Data analysis software and the mean differences were adjusted by Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

Results obtained from the present study have been presented and discussed in this chapter with a view to study the effect of different preservatives on vase life extension of Chrysanthemum, Aster and Button flower. The data are given in different tables and figures. The results have been discussed, and possible interpretations are given under the following headings.

Experiment 1: Effect of different preservative solutions on vase life of chrysanthemum flower

4.1 Water uptake (g/spike)

The cut flowers kept in different preservative solutions differed significantly for total water uptake for a period of 12 days by the chrysanthemum flower spike (Table 1).

Table 1. Effect of different preservatives on water uptake, water loss, water loss to water uptake ratio and water balance of chrysanthemum

Treatment	Water uptake (g/spike)	Water loss (g/spike)	Water loss to water uptake ratio	Water balance
T_0	15.00 e	17.67 f	1.18 a	-2.67 h
T_1	18.67 d	19.67 cd	1.05 b	-1.00 g
T_2	19.33 d	20.00 c	1.03 b	-0.67 f
T_3	19.33 d	19.00 e	0.98 c	0.33 e
T_4	22.00 c	21.00 b	0.95 c	1.00 d
T_5	23.33 b	19.33 de	0.83 e	4.00 b
T_6	22.67 bc	19.67 cd	0.87 d	3.00 c
T_7	27.00 a	21.67 a	0.80 e	5.33 a
LSD $_{(0.05)}$	0.86	0.64	0.04	0.06
CV (%)	2.39	1.87	2.33	3.03

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0 : Control(tap water), T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$ + 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

The result showed that the maximum water uptake of spike (27.00 g) was recorded for chrysanthemum flower in T_7 solution whereas the minimum water uptake (15.00 g)per spike was noted in T_0 (Tap water) solution . The result obtained from the present study was similar with the findings of Zamani *et al.* (2011) and they showed that sucrose at 3 %, citric acid, malic acid and salicylic acid increasing water uptake in Chrysanthemum cut flowers.

4.2 Water loss (g/spike)

A significant variation for water loss from spike which kept in different vase solution (Table 1) showed in this experiment. Experimental result showed that chrysanthemum flower spike kept in solution containing T_0 had minimum water uptake and recorded minimum water loss from the spike (17.67 g/spike) comparable to flower spike kept indifferent preservative solutions whereas, chrysanthemum flower spike kept in solution T_7 and recorded the maximum water loss (21.67 g/spike) comparable to others treatment. This was happened due to uptake of water from respective vase solution.

4.3 Water loss to water uptake ratio

The ratio of water loss to water uptake is significantly affected by different preservative solutions (Table 1). Experimental result showed that T_0 solution recorded the maximum water loss to water uptake ratio (1.18) whereas chrysanthemum flowers spike kept in different preservative solutions comparatively had lower water loss to water uptake ratio than control treatment and the minimum water loss to water uptake ratio (0.80) was recorded in solution containing T_7 which was statistically similar with T_5 (0.83) solution.

4.4 Water balance (g)

It would be seen from table-1 that chrysanthemum flower spike kept in solution containing T_7 recorded the maximum water balance (5.33 g) whereas the chrysanthemum flower spike held in solution containing no preservatives (T_0 Control) recorded the minimum balance (-2.67 g). The result obtained from the present study was similar with the findings of Patel *et al.* (2016) and they reported that application

of different preservatives prevent blockage of vessels and retain ethylene an optimum level resulting in prolonged fresh vase life of cut flower.

4.5 Fresh weight of spike (g)

Figure-1 represent the changes of fresh weight of chrysanthemum flower spike kept in different preservative solutions up to 12th day at 2 days interval. From the graphical representation it was observed that all treatments including control treatment, a gentle increase in fresh weight of spike was noted up to 5th day. There after depletion in weight of chrysanthemum flower spike was observed, those held in tap water. Increasing trend continued up to 7-9 days in the chrysanthemum flower spike held in preservative solution containing different levels of sucrose, salicylic acid, citric acid and $AgNO_3$. However the maximum fresh weight of chrysanthemum flower spike (18.6 g) was observed in solution containing T_7 at 9th day. This was happened due to uptake of water from respective vase solution.

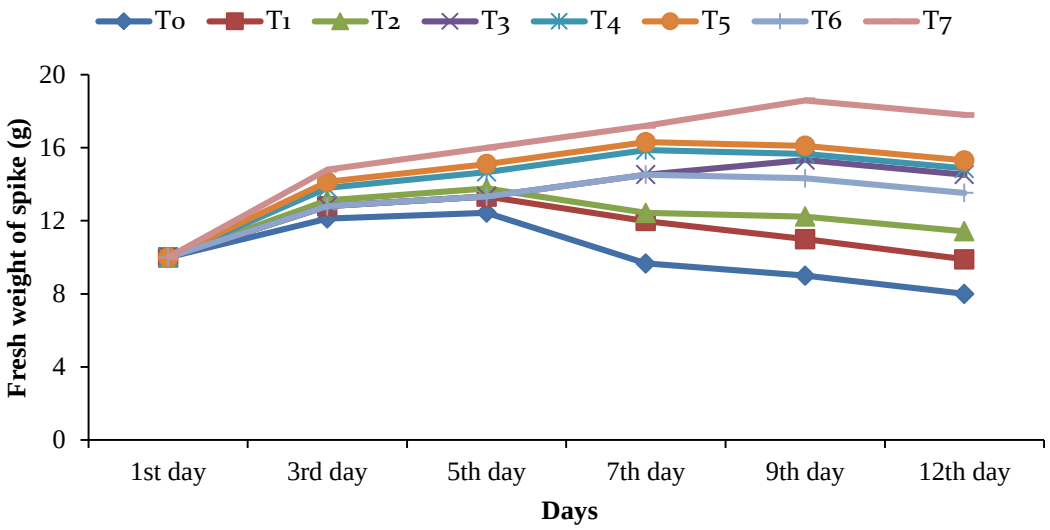

Figure. 1. Effect of different preservative solutions on fresh weight of spike of chrysanthemum flower at different days

(Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$ + 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.)

4.6 Vase life (days)

Vase life refers to the length of time that a bouquet or any bunch of cut flowers retains their appeal and aesthetic value, especially when sitting in stagnant water. In this experiment chrysanthemum flower spike vase life significantly differ due to effect of different preservative solutions (Fig. 2). Experimental result revealed that the maximum vase life (9.33 day) in T_7solution whereas the minimum vase life (4.33 day) was found in T_0 solution.

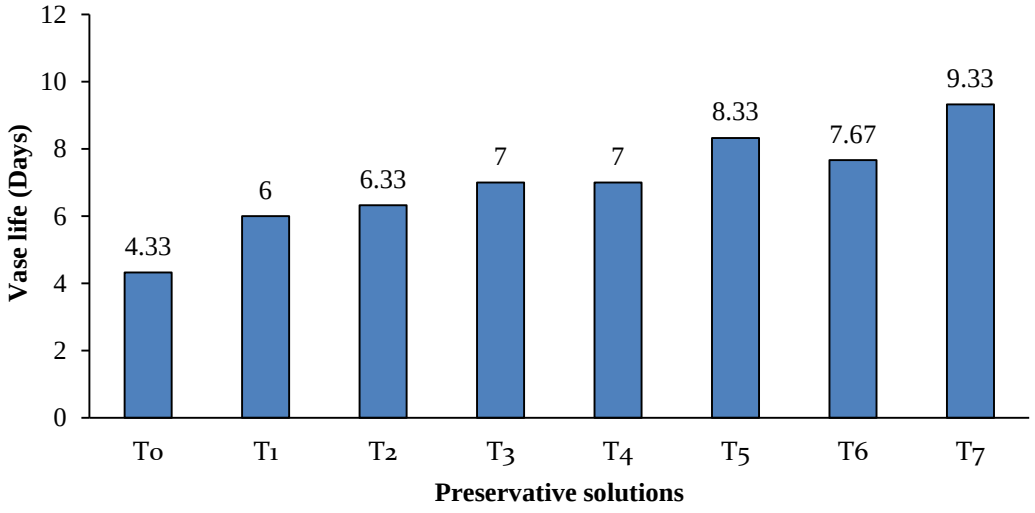

Figure 2. Effect of different preservative solutions on vase life of chrysanthemum flower

Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose +200 ppm $AgNO_3$ + 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

4.7 Incidence of stem rotting (days)

Preservative solutions affected the incidence of stem rotting (Figure 3). Experimental findings showed that stem rotting was started after 12 days in T_7 solution and 6 days for T_0 solution. The differences of incidence of stem rotting on chrysanthemum flower spike might be due to the fact that $AgNO_3$ present in the in the vase solution. $AgNO_3$

acted as a biocide and ethylene binding inhibitor. AgNO3 greatly reduce microbial population in vase solution that might have resulted in blockage of the vascular tissues and improve water uptake by the cut stem, which helps in increasing flower diameter and vase life of flower.

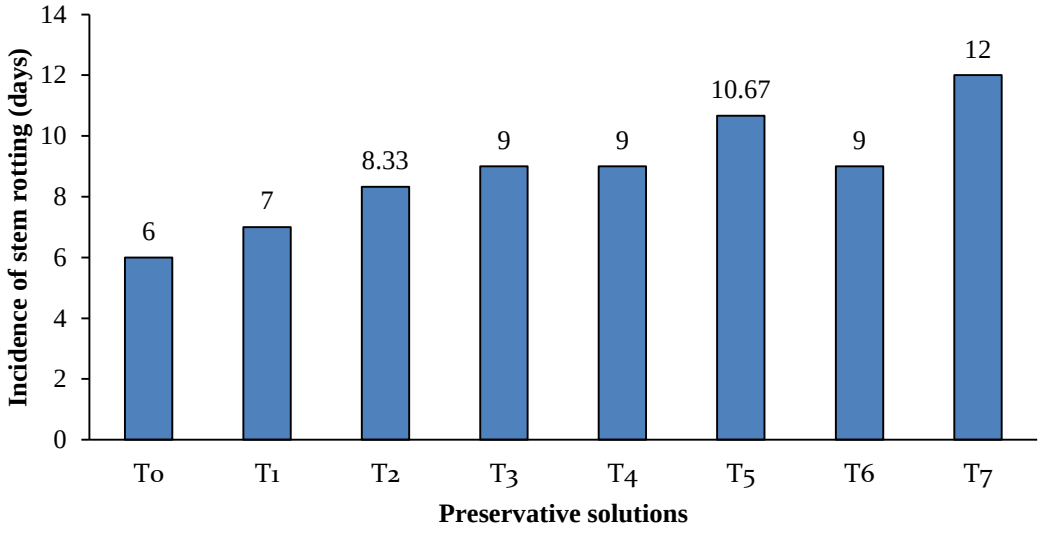

Figure 3. Effect of different preservative solutions on incidence of stem rotting of chrysanthemum flower

Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose +200 ppm $AgNO_3$ + 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

Experiment 2: Effect of different preservative solutions on vase life of Aster flower

4.8 Water uptake (g/spike)

The water uptake via the cut flowers placed in a keeping solution resulted in better water balance and flower freshness and reduced early wilting and thus the vase life of the cut flowers was enhanced. The cut flowers held in different preservatives differed significantly for total water uptake for a period of 12 days by the aster flower spike (Table 2).

Table 2. Effect of different preservatives on water uptake, water loss, water loss to water uptake ratio and water balance of aster

Treatment	Water uptake (g/spike)	Water loss (g/spike)	Water loss to water uptake ratio	Water balance
T_0	10.67 f	12.67 f	1.19 a	-2.00 g
T_1	16.33 d	17.00 b	1.04 b	-0.67 f
T_2	17.67 b	17.00 b	0.96 c	0.67 e
T_3	16.33 d	15.67 c	0.96 c	0.66 e
T_4	14.67 e	13.67 e	0.93 c	1.00 d
T_5	16.33 d	13.67 e	0.84 d	2.66 b
T_6	17.00 c	14.67 d	0.86 d	2.33 c
T_7	21.67 a	18.00 a	0.83 d	3.67 a
$LSD_{(0.05)}$	0.61	0.80	0,06	0.07
CV(%)	2.16	3.03	3.97	4.15

(In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm$AgNO_3$ + 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.)

The result showed that the maximum water uptake of spike (21.67 g) was recorded for aster flower kept in T_7 solution whereas the minimum water uptake (10.67 g) per spike was noted in T_0 (Tap water) solution. The result obtained from the present study was similar with the findings of Kazemi *et al.* (2011) who declared that salicylic acid, citric acid and ascorbic acid on flower, improve quality and floret diameter of different cut flower crops.

4.9 Water loss (g/spike)

Water deficit have direct effect on turgor of cut flowers, which accelerates wilting and senescence. Its showed a significant variation for water loss from spike which kept in different vase solution (Table 2). Experimental result showed that aster flower spike kept in solution containing T_0 had minimum water uptake and recorded minimum water loss from the spike (12.67g/spike) comparable to flower spike kept in different preservative solutions. Whereas aster flower spike kept in solution T_7 and recorded the maximum water loss (18.00g/spike) comparable to others treatment.

4.10 Water loss to water uptake ratio

The ratio of water loss to water uptake is significantly affected by different preservative solutions (Table 2). Experimental result showed that T_0 solution recorded the maximum water loss to water uptake ratio (1.19) whereas the minimum water loss to water uptake ratio (0.83) was recorded in T_7 solution which was statistically similar with T_5 (0.84) and T_6 (0.86) solution.

4.11 Water balance

The overall water balance in this experiment followed the same trend, but data illustrated in (Table 2) revealed that aster flowers which were treated withT_7 had been showed better water balance (3.67 g) than those with other treatments. Results of the present study may be explained on basis that aster flower spike held in solution containing T_7 plays an important role in improving the water balance by preventing the growth of microorganism in xylem and thus maintained water uptake by flower stems.

4.12 Fresh weight of spike (g)

Figure-4 represent the changes of fresh weight of aster flower spike kept in different preservative solution up to 12th day at 2 day interval. From the graphical representation it was observed that all treatments including control treatment, a gentle increase in fresh weight of spike was noted up to 3th day. There after depletion in weight of aster flower spike was observed, those held in tap water. Increasing trend continued up to 5-7 days in the aster flower spike held in preservative solution containing different levels of sucrose, salicylic acid, citric acid and $AgNO_3$. However, the maximum fresh weight of aster flower spike (14.72 g) was observed in T_7 solution at 7th day.

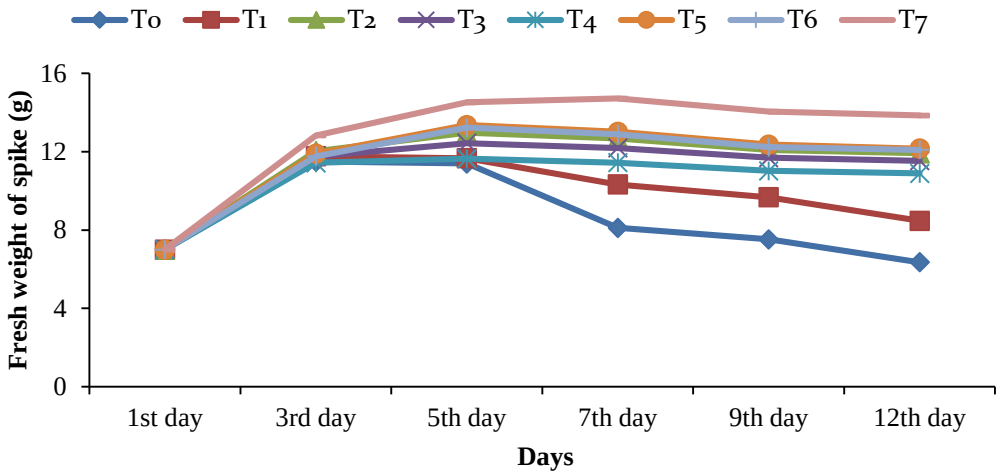

Figure 4. Effect of different preservative solutions on fresh weight of spike of aster flower at different days

(Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid)

4.13 Vase life (days)

In this experiment, vase life significantly differ due to effect of different preservative solutions (Fig. 5). Experimental result revealed that maximum vase life (8 day) in T_7 solution whereas the minimum vase life (3 day) was found in T_0 solution. These results may be due to the role of salicylic acid, citric acid and $AgNO_3$ as antimicrobial agent and hence, it might reduce stem plugging. Sugars alone, however, tends to promote microbial growth. However, the combination of sugars and biocides might have extended the vase life of cut flowers. Shirin and Mohsen (2011) also found similar result which supported the present finding and reported that, different chemical combinations with sucrose increase the post-harvest life of cut flowers and their physiological characteristics.

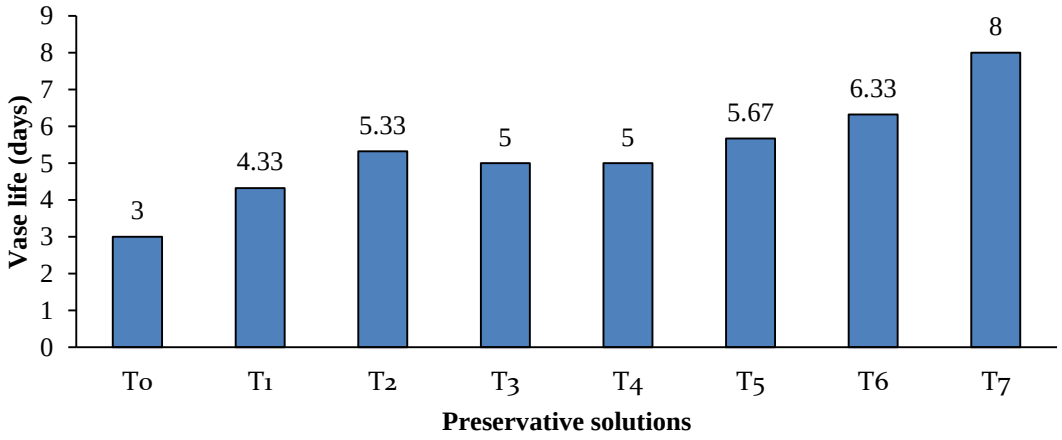

Figure 5. Effect of different preservative solutions on vase life of aster flower

Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid

4.14 Incidence of stem rotting (days)

Preservative solution significantly affected the incidence of stem rotting (Figure 6). Experimental findings showed that stem rotting was started after 11.67 days in T_7 solution and 4.33 days for T_0 solution. Stem rot is a disease caused by a fungus

infection in the stem. The differences of incidence of stem rotting on aster flower spike might be due to the fact that $AgNO_3$ present in the in the vase solution.

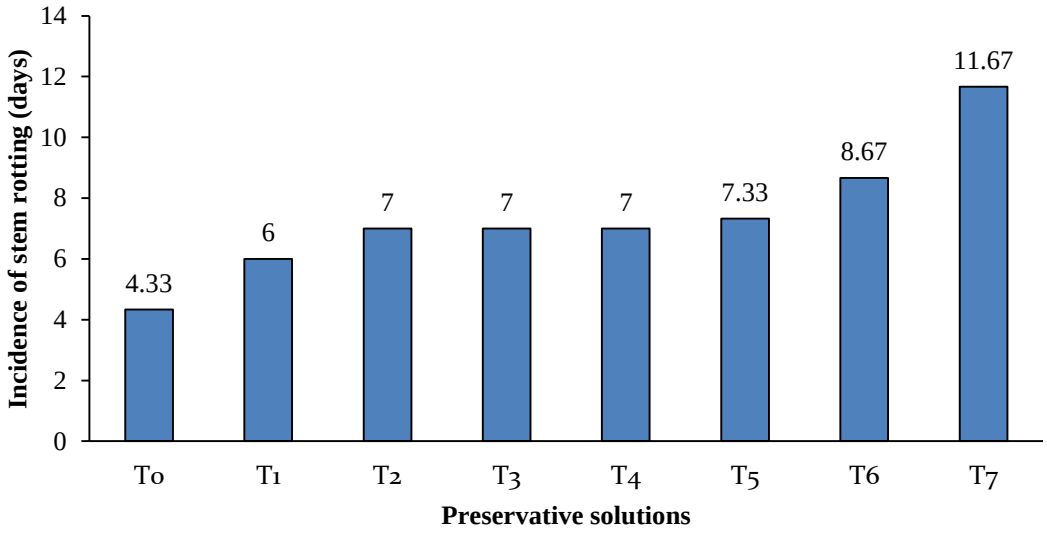

Figure 6. Effect of different preservative solutions on incidence of stem rotting of aster flower

Here, T_0: Control, T_1: 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

Experiment 3: Effect of different preservative solutions on vase life of button flower

4.15 Water uptake (g/spike)

The cut flowers kept in different preservative solutions differed significantly for total water uptake for a period of 12 days by the button flower spike (Table 3).

Table 3. Effect of different preservatives on water uptake, water loss, water loss to water uptake ratio and water balance of button flower

Treatment	Water uptake (g/spike)	Water loss (g/spike)	Water loss to water uptake ratio	Water balance
T_0	9.55 f	11.88 e	1.25 a	-2.33 h
T_1	11.68 e	13.00 d	1.11 b	-1.32 g
T_2	12.00 de	13.10 d	1.09 b	-1.10 f
T_3	12.60 d	13.68 c	1.08 b	-1.08 e
T_4	12.00 de	13.00 d	1.08 b	-1.00 d
T_5	14.68 c	13.00 d	0.89 c	1.68 c
T_6	16.33 b	14.33 b	0.88 c	2.00 b
T_7	18.32 a	15.60 a	0.85 c	2.72 a
$LSD_{(0.05)}$	0.87	0.27	0.08	0.006
CV(%)	3.73	1.17	4.74	6.58

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

The result showed that the maximum water uptake per spike (18.32g) was recorded for button flower kept in T_7 solution recorded whereas the minimum water uptake (9.55g) per spike was noted in T_0 (Tap water) solution. The experiment results suggested that sugar-containing preservatives could significantly promote the water absorption of branches, improve the water balance and supply, and ensure the transportation of other materials (e.g., sugar), thus effectively alleviating the wilting process of fresh flowers, and prolong the vase life of cut flowers.

4.16 Water loss (g/spike)

A significant variation for water loss from spike which kept in different vase solution (Table 3). Experimental result showed that button flower spike kept in solution containing T_0 had minimum water uptake and recorded minimum water loss from the spike (11.88 g/spike) comparable to flower spike kept in different preservative solutions. Whereas button flower spike kept in solution T_7 and recorded the maximum water loss (15.60 g/spike) comparable to others treatment. The result obtained from the present study was similar with the findings of Angel and Vignesh (2021) and they reported that the maximum water uptake, transpiration loss of water was recorded in T_5 (8-Hydroxy Quinoline Sulphate @ 300 ppm + sucrose 4%), when compared to control. Water loss have direct effect on turgor of cut flowers, which accelerates wilting and senescence

4.17 Water loss to water uptake ratio

The ratio of water loss to water uptake is significantly affected by different preservative solutions (Table 3). Experimental result showed that T_0 solution recorded the maximum water loss to water uptake ratio (1.25) whereas the minimum water loss to water uptake ratio (0.85) was recorded in solution T_7 which was statistically similar with T_5 (0.89) and T_6 (0.88) solution. Higher water loss to water uptake ratio deteriorate vase life of cut flowers as increasing transpiration and lower uptake occurred physiological disorders of ornamental flowers after harvest, which reduced the vase life and quality of flowers.

4.18 Water balance (g)

In this experiment result showed that button flower spike held in different preservative solutions influenced water balance (Table 3). Experimental result showed that button flower spike kept in T_7 solution recorded the maximum water balance (2.72 g) whereas minimum balance was (-2.33 g) in T_0.

4.19Fresh weight of spike (g)

Figure-7 represent the changes of fresh weight of button flower spike held in different preservative solution up to 12th day 2 day interval. From the graphical representation it was observed that all treatments including control treatment, a gentle increase in fresh weight of spike was noted up to 7th day. There after depletion in weight of button flower spike was observed, those kept in tap. Increasing trend continued up to 7-9 days in the button flower spike kept in preservative solution containing different levels of sucrose, salicylic acid, citric acid and $AgNO_3$. However, the maximum fresh weight of button flower spike (9.84 g) was observed in T_7 solution at 9th day.

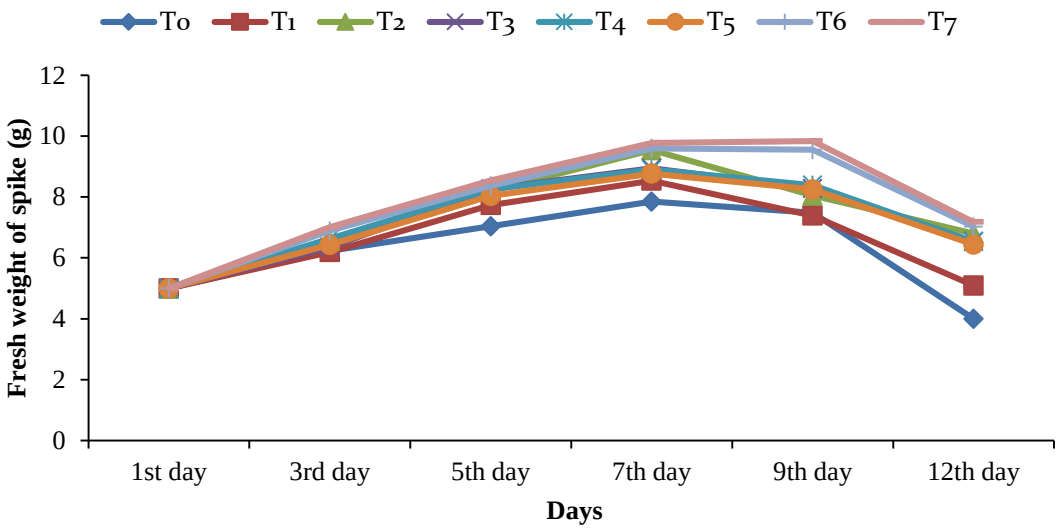

Figure 7. Effect of different preservative solutions on fresh weight of spike of button flower at different days

Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

4.20 Vase life (days)

In this experiment, button flower spike vase life significantly differ due to effect of different preservative solutions (Fig. 8). Experimental result revealed that maximum vase life (10.33 days) in T_7solution whereas the minimum vase life (4.33 days) was found in T_0 solution. Angel and Vignesh (2021) also found similar result which supported the present finding and reported that the maximum vase life was recorded in T_5 (8-Hydroxy Quinoline Sulphate @ 300 ppm + sucrose 4%), when compared to control.

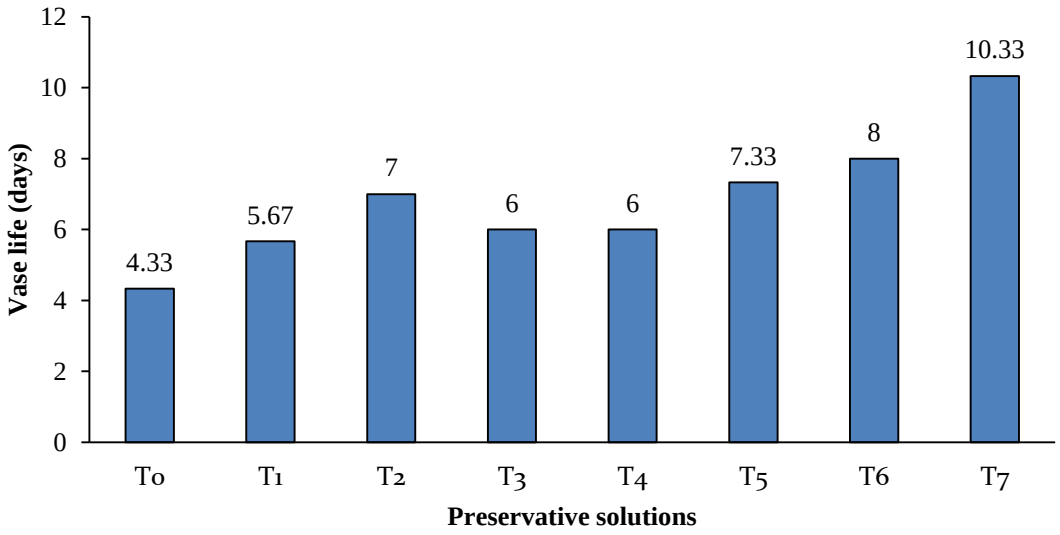

Figure 8. Effect of different preservative solutions on vase life of button flower

Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

4.21 Incidence of stem rotting (days)

Preservative solution significantly affect the incidence of stem rotting (Figure 9). Experimental findings showed that stem rotting was started after 12 days in T_7 solution and 5.33 days for T_0 solution.

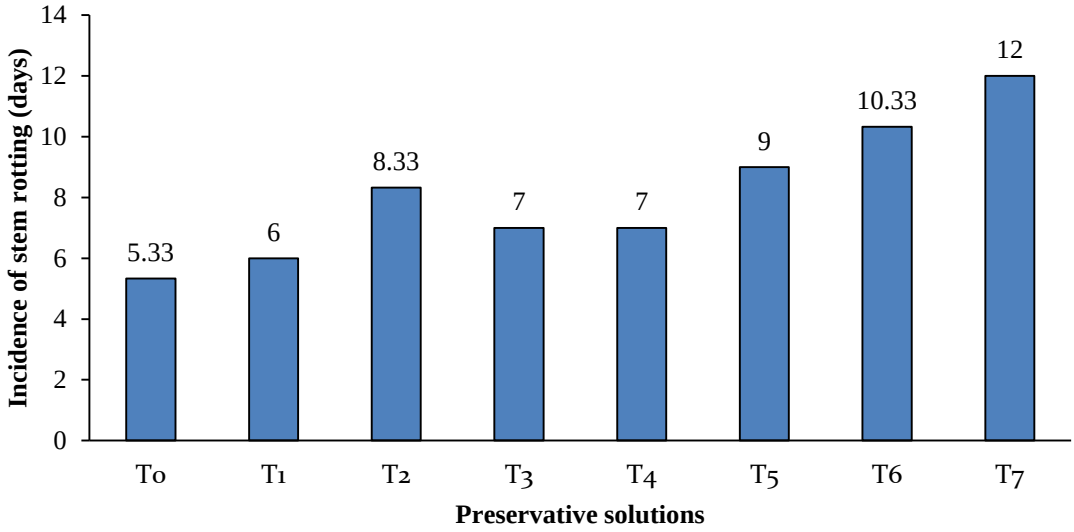

Figure 9. Effect of different preservative solutions on incidence of stem rotting of button flower

Here, T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid.

CHAPTER V

SUMMARY AND CONCLUSION

Three experiments were conducted in the Horticultural Biotechnology and Stress Management Lab of Sher-e-Bangla Agricultural University, Dhaka to investigate the effect of different preservatives on vase life extension of Chrysanthemum, Aster and Button flower. The experiment was consisted of eight treatments (preservatives) *viz:*T_0 : Control, T_1 : 3 % sucrose, T_2 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm citric acid, T_3 : 3 % sucrose + 250 ppm salicylic acid + 100 ppm citric acid, T_4 : 3 % sucrose + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_5 : 3 % sucrose + 200 ppm $AgNO_3$+ 100 ppm citric acid, T_6 : 3 % sucrose + 200 ppm salicylic acid + 100 ppm $AgNO_3$ + 100 ppm citric acid, T_7 : 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid,followed Completely Randomized Design (CRD) with three replications. Data on different parameters were collected for assessing results for this experiment and showed significant variation due to the effect of different treatments.

In case of Chrysanthemum flower experimental result showed that, chrysanthemum flower spike kept in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment) recorded the maximum water uptake (27.00 g/spike) and water loss (21.67 g/spike). The maximum water loss to water uptake ratio (1.18) was recorded in control treatment. Chrysanthemum flower spike kept in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment) recorded the maximum water balance (5.33 g), fresh weight of flower spike (18.6 g), vase life (9.33 day) and maximum (12.00 day) required for incidence of stem rotting. Whereas control treatment (T_0) recorded the minimum water uptake (15.00 g/spike) and water loss from the spike (17.67 g/spike). The minimum water loss to water uptake ratio (0.80) was recorded in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment). Chrysanthemum flower spike held in solution

containing no preservatives (T_0 Control) recorded the minimum balance (-2.67g), vase life (4.33 day) and minimum (6.00 day) required for start incidence of stem rotting.

In case of Aster flower experiment result showed that, aster flower spike kept in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment) recorded the maximum water uptake (21.67 g/spike) and water loss (18.00 g/spike). The maximum water loss to water uptake ratio (1.19) was recorded in tap water. Aster flower spike held in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment) recorded the maximum water balance (3.67 g), fresh weight of flower spike (14.72 g), vase life (8 day) and maximum (11.67 day) required for incidence of stem rotting. Whereas control treatment (T_0) recorded the minimum water uptake (10.67 g/spike) and water loss from the spike (12.67 g/spike). The minimum water loss to water uptake ratio (0.83) was recorded in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment). Aster flower spike held in solution containing no preservatives (T_0 Control) recorded the minimum balance (-2.00 g), vase life (3.00 day) and minimum (4.33 day) required for start incidence of stem rotting.

In case of button flower experiment result showed that, button flower spike kept in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment) recorded the maximum water uptake (18.32 g/spike) and water loss (15.60 g/spike). The maximum water loss to water uptake ratio (1.25) was recorded in control treatment. Button flower spike kept in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid(T_7 treatment) recorded the maximum water balance (2.72 g), fresh weight of flower spike (9.84 g), vase life (10.33 day) and maximum (12 day) required for incidence of stem rotting. Whereas control treatment (T_0) recorded the minimum water uptake (9.55 g/spike) and water loss from the spike (11.88 g/spike). The minimum water loss to water uptake ratio (0.85) was recorded in solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid (T_7 treatment). Button flower spike held in solution containing no preservatives (T_0 Control) recorded the minimum balance (-2.33 g), vase life (4.33 day) and minimum (5.33 day) required for start incidence of stem rotting.

Conclusion

From the result of the three experiments, it may be concluded that T_7 solution containing 3 % sucrose +250 ppm salicylic acid + 200 ppm $AgNO_3$ + 100 ppm citric acid could be considered the best preservative solutions for Chrysanthemum, Aster and Button flower to extend the longevity and keeping quality.

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APPENDICES

Appendix I. Analysis of variance of the data of water uptake, water loss, water loss to water uptake ratio and water balance of chrysanthemum flower due to effect different preservatives

Mean square of							
Source	Df	Water uptake	Water loss	Water loss to water uptake ratio	Water balance	Vase life	Incidence of stem rotting
Treatments	7	39.50 **	4.452 **	0.048**	22.38**	6.953**	10.76**
Error	16	0.2500	0.13625	0.00050	0.0013	0.02723	0.1386
Total	23						

**: Significant at 0.01 level of probability

Appendix II. Analysis of variance of the data of water uptake, water loss, water loss to water uptake ratio and water balance of aster flower due to effect different preservatives

Mean square of							
Source	Df	Water uptake	Water loss	Water loss to water uptake ratio	Water balance	Vase life	Incidence of stem rotting
Treatments	7	28.09**	11.064**	0.043**	10.13**	6.3819**	13.59**
Error	16	0.1250	0.2154	0.00142	0.0019	0.01136	0.0126
Total	23						

**: Significant at 0.01 level of probability

Appendix III. Analysis of variance of the data of water uptake, water loss, water loss to water uptake ratio and water balance of button flower due to effect different preservatives

Mean square of							
Source	Df	Water uptake	Water loss	Water loss to water uptake ratio	Water balance	Vase life	Incidence of stem rotting
Treatments	7	24.330**	3.7048**	0.0608**	10.60**	9.8019**	15.23**
Error	16	0.2500	0.02486	0.00239	1.250e-05	0.02250	0.0272
Total	23						

**: Significant at 0.01 level of probability

Plate 1. Placement of chrysanthemumflower stick in bottle

Plate 2. Floret deterioration of chrysanthemum flower in vase

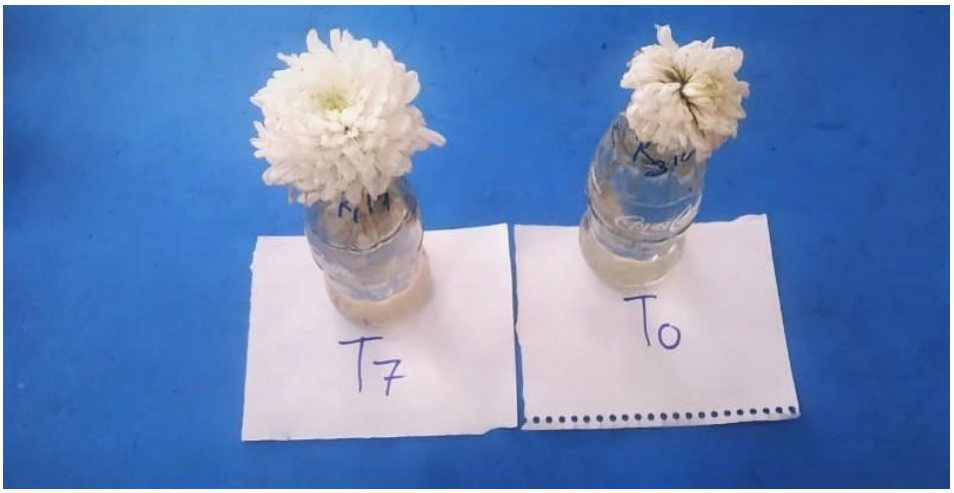

Plate 3. Chrysanthemum flower kept in vase solution containing preservatives (T_7) and non preservatives (T_0) and their effect on vase life at last day

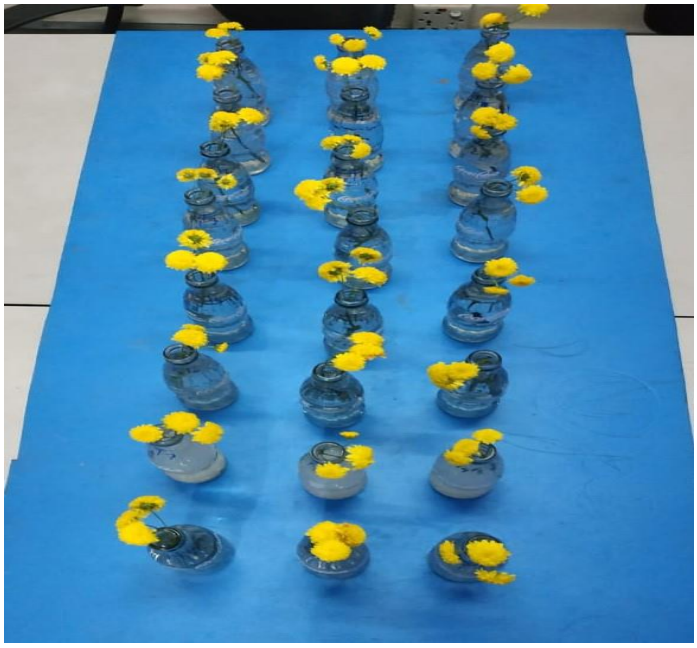

Plate 4. Placement of button flower stick in bottle

Plate 5. Floret deterioration of button flower in vase

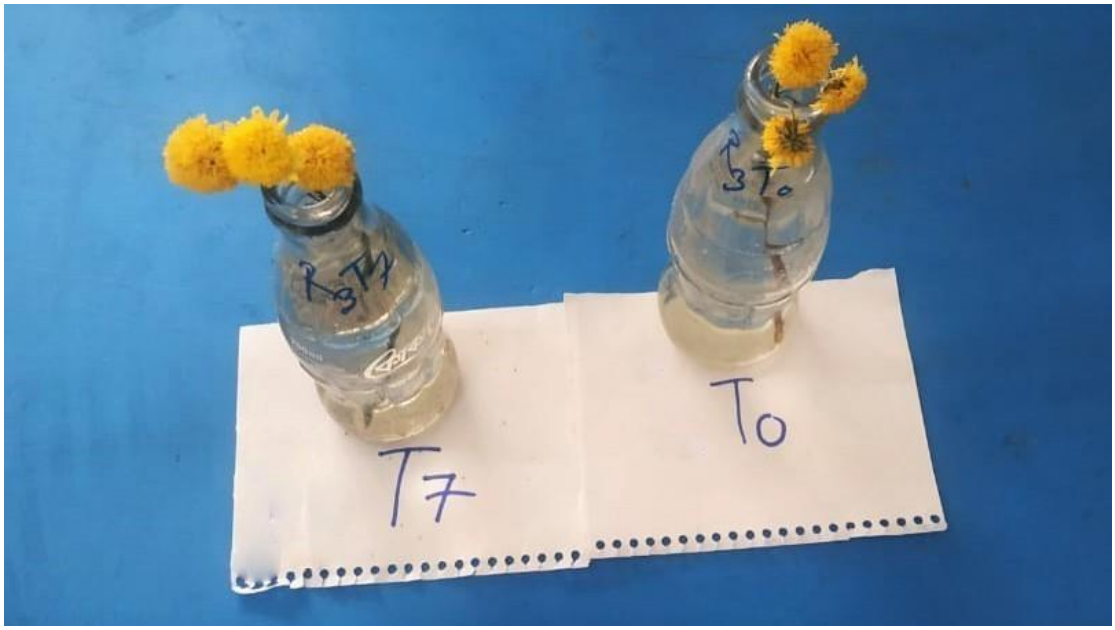

Plate 6. Button flower kept in vase solution containing preservatives (T_7) and non preservatives (T_0) and their effect on vase life at last day