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Effects of Preservative Solutions on Shelf Life and Quality of Cut *Gypsophila* Flowers, Ethiopia

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ABSTRACT

Extending the vase life of cut flowers is one of the serious problems of the floriculture industry in the study area. To this purpose, different types of preservatives have been used to prolong the shelf life of cut flowers. Therefore, the present experiment was initiated to identify a suitable pulsing preservative to prolong the vase life of Gypsophila at TAL Flower Farms PLC, Bahir Dar Zuria District, Ethiopia. The design was completely randomized and was replicated three times. The treatments included three varieties of Gypsophila (overtime, magnet, and Blancanieves) and five preservative solutions (Aluminium Sulphate, TOG-3, Silver thiosulphate, sugar, and distilled water). Data on solution uptake, water loss, fresh weight, flower opening percentage, vase life, and thickness were collected, and analyzed by SAS software. Both the variety of Gypsophila and pulsing preservatives and their interactions affected most of the parameters tested in the study. Pulsing Gypsophila flowers with silver thiosulphate recorded the best results in all parameters except flower stem thickness. On the other hand, the Magnet variety, followed by overtime, had the longest vase life and quality. The magnet variety pulsed with silver thiosulphate preservative recorded the highest solution uptake, water loss through transpiration, flower fresh weight, flower opening percentage, and maximum vase life day. Therefore, silver thiosulphate preservative can be used to prolong the vase life of Gypsophila flowers, where a combination of Silver Thiosulphate and magnet varieties of Gypsophila recorded the highest vase life.

Keywords: *Gypsophila paniculata, Preservative solution, Vase life, Quality of flower*

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INTRODUCTION

Gypsophila is a genus of well-known, cultivated, attractive, and medicinal plants that are a member of the Caryophyllaceae family. As of right present, the genus *Gypsophila* contains more than 150 species. In Europe and Asia, they are found between 30° and 60° latitude. *Gypsophila* is a long-day plant; in short-day situations, flowering can be encouraged with the application of specialized lights. Furthermore, higher nighttime temperatures in the summer might cause deformity in flowers (Doe, 2006). *Gypsophila* grown in chilly climates in summer. Numerous *Gypsophila* cultivars with different flowering times and colors have been created. The "Bristol Fairy" cultivar is the most frequently used early flowering variety due to its prolific and high-quality flowers. Perfecta, a late-flowering cultivar with varying flower colors from white to pink, and 'Red Sea,' a well-known cultivar with pink flowers, are two of its selections. Since floral deformity is uncommon, even in the summer, the magic series cultivars' high-temperature tolerance is fully utilized (Doe, 2006).

One of the most important aspects of the quality of life of cut flower vases is customer happiness. High-quality flowers with a longer postharvest life, marketability, and commercial worth of cut flowers are required for the cut flower market. Cut flowers are actively digested organs, much like other parts of the plant, therefore they begin to degrade as soon as they are harvested, resulting in postharvest losses (Da Silva, 2003).

Fresh flowers lose approximately 20% of their freshness during market distribution. Due to physiological and pathological issues during post-harvest processing, the majority of the surviving flowers are sold in low-quality conditions, leaving the consumer unsatisfied (Asfanani *et al*., 2008). Cut flowers lose their beauty and appeal after a few days under typical circumstances. However, most people choose to appreciate them in their natural beauty and appearance for a longer period, having the socioeconomic value of flowers intact. Physiological obstruction of the stem capillaries by microbial growth and air bubble generation are two possible causes of the decrease in water intake, depending on the species. With the obstruction of conducting vessels, the development of negative water balances occurs, because the rate of water absorption is less than the rate of transpiration (Onozaki & Azuma, 2019).

To satisfy customers and benefit the business, using the right preservatives could assist in harvesting produce and have a longer vase life. Preservative treatments are often necessary to offer energy sources, prevent microbial build-up and vascular blockage, increase water uptake of the stem, and stop the negative effects of ethylene (Nigussie, 2005). To extend the vase life of cut flowers, it is recommended to add various chemical preservatives to the holding solution (vase) (Ichimura *et al*., 2006).

In this regard, several preservatives are used around the world to extend the vase life of various cut flowers, including sucrose, 8-hydroxyquinoline sulfate (8-HQS), ethanol extracts, silver thiosulphate, and citric acid. Sucrose prevents ethylene production and encourages bud expansion, which prevents flowers, including cut snapdragon flowers—from senescing (Rabiza-Świder *et al.*, 2020). Furthermore, 8-hydroxy quinoline salts (8-HQS) delayed senescence and eradicated bacterial development, which was the major reason for reduced water intake during the transit of gerbera flower. The addition of a germicide, such as 8-HQS, is required when sucrose is present to prevent microbial development. Similarly, Waithaka *et al*. (2001) found that treating cut flowers with a pulse solution (20% sucrose + 250 ppm 8 HQC) greatly increased their vase life and opening. The 8 HQS preserved flower stems' ability to absorb water by preventing the growth of microbes in the xylem. However, the most potent bactericide and ethylene generation and activity inhibitor was silver thiosulphate (STS) (Nowak *et al*., 1990). According to Beura and Singh's (2001) gladiolus research, pulsating spikes with 20% sucrose and 4 mm silver thiosulphate produced the longest-lasting florets and longest vase life. In addition, citric acid has been found to reduce stem clogging and enhance water balance. However, many cut flower growers in Ethiopia rarely put energy sources or preservatives as post-harvest treatment to prolong the shelf life of cut flowers, which consequently increases postharvest losses and reduces foreign exchange earnings.

Since cut flowers are living things that need to breathe after being harvested, the floriculture sector is experiencing significant post-harvest losses. The timing of harvesting, post-harvest handling procedures (such as transportation and type of cut flowers), and other variables affect the amount of post-harvest losses and the longevity of cut flowers. Cut flowers often only live for a very short time after being removed from the mother plant, since their unique morphological and physiological traits make it difficult for them to survive in their reserves.

The main cause of degradation in cut flowers is the obstruction of xylem arteries by bacteria. Air embolism, the plant's natural reaction to cutting the stem, is another significant factor that contributes to vascular occlusion. Water absorption decreases when xylem artery blockage occurs, while transpiration-related water loss persists. As a result, the net water gain steadily decreases, causing the flowers to wilt, lose quality, and eventually die. In contrast, a variety of floral preservatives is used globally to extend the vase life of cut flowers (Ichimura *et al*., 2006). These preservatives act as an energy supply, prevent microorganisms from growing, and prolong the freshness of cut flowers. Thus, it stimulates the absorption of water by the reduction of vascular blockage, helping to maintain the turgor of flowers.

In Ethiopian floriculture, these preservatives are not widely used. For instance, in the research area, Cold Rails delivers cut flowers to Bole International Airport in Addis Ababa, Ethiopia since they are unable to utilize the cargo flight for the direct market. Preservatives can have an impact on the vase life of flowers, which is badly affected by long-distance shipping. However, because the suggested preservatives are not available, the research area does not apply preservatives for *Gypsophila* cut flowers. The effectiveness of preservatives differs with environmental conditions, the rate and type of preservative used, and the variety of flowers. Thus, the purpose of this study is to determine how preservatives affect the shelf life of different types of *Gypsophila* and to suggest the best preservatives for extending the shelf life beyond harvest.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at TAL Flower Farms PLC, Bahir Dar district, Ethiopia from October 2018 to March 2019. It was established in 2016 to grow and export only the *Gypsophila* variety. The farm is found at an elevation of 1950 m. a. s. l and 390 10-east latitude. It is endowed with a good climate and completely random and has excellent well-drained red soil (clay loam); the pH of the soil is 6.5 and ample fresh water is obtained from the well. The average rainfall is 1050 mm and the relative humidity is 60%. The minimum and maximum temperatures are about 14 °C and 28 °C, respectively. The study was carried out in a greenhouse at a room temperature of 27 °C and a relative humidity of 70 °C. (Bahir Dar Zuria District of Agricultural Office/BZDoA, 2019).

Experimental treatments, design, and procedures

About three types of *Gypsophila*—Overtime, Magnet, and Blancanieves, as well as five pulsing solutions: sugar (20 g/l), aluminum sulfate (AlSO4) 250 mg/lit, silver thiosulphate (STS) 0.5 ml/l, TOG-3 0.6 mg/l, and distilled water—were utilized as treatments in this investigation. Three replications of a completely randomized design were used to organize the treatments.

Gypsophila cut flowers with two to three opened petals picked early in the morning and placed right into the water-filled harvesting buckets, covering around 15 centimeters of the flower stem. During harvesting, the cut flower buckets were put under shade and then transferred immediately to the packinghouse, where were maintained for 24 hours at room temperature. To achieve green processing, all leaves and foliage were removed. The ready-made flowers were grouped into five stems. Five flower stems with a uniform length of 70 cm and opening stage were included in an experiment vase. An experimental flask holding 1000 cc of the preservation solutions held the prepared flower bunch. The prepared flasks with cut flowers were put in the Greenhouse. At the time of transfer to the experimental flask, about a 2 cm long stem was cut off at the bottom to improve the transport of water through the flower stem, and recut was done at once for all treatments before immersion in preservative solutions.

Data collection and analysis

- *Solution uptake (g):* measured by the weight of vases containing vase solutions without the cut flowers were recorded daily during the vase life evaluation period. For determining water uptake, flasks were weighed with the solution without flowers, and the consecutive difference in weight signifies the solution uptake. Each flower species and cultivar may adapted to various constituents and concentrations in the solution (Skutnik *et al*., 2020).

- *Water loss (g):* up until the end of the vase's life, the weight of the cut flowers was measured daily. The process was repeated daily, and the weight loss was determined as the difference between the fresh weights of cut flowers and the weight of the solution.
- *Water balance (g):* until the experiment's conclusion, the water balance was determined by subtracting the amount of water lost from the amount of water taken in.
- *Fresh weight (g):* Fresh weights of *Gypsophila* flowers were measured daily during vase life. The original fresh weight was measured before immersion in the keeping solution. The flask was weighed with flask + solution + flowers and the weight of the flask and solution was subtracted the difference in the weight signifies the fresh weight of the flowers. This process was repeated every day, and the weight per flower bunch was computed.
- *Flower opening percentage (%):* the flower opening percentage was determined as a percentage of open florets from all the flowers on the cut cluster spike (inflorescence).
- *Flower vase life (day):* The vase life was determined by counting the number of days from the date of experiment setup up to the date when 50% of the bunch of flowers wilted or senesced.
- *Flower stem thickness (cm):* The thickness of three randomly selected flower stems was measured every three days from day 0 until the end of the experiment using a caliper.

All the collected data were analyzed statistically using the SAS version 9.2 software computer package program. The Least Significant Difference (LSD) procedure was used to determine differences between treatment means whenever treatments were significantly different.

RESULTS AND DISCUSSION

Effect of floral preservatives on the uptake of Gypsophila varieties

The findings of the variance analysis showed that there was no significant ($P > 0.05$) influence on the daily intake of cut *Gypsophila* flower types. On the other hand, **Table 1** shows that the preservatives and their combination had a very strong ($P < 0.001$) impact on the solution's absorption. When the magnet variety was preserved in the preservative, the interaction effect showed the highest solution uptake. This was followed by the overtime variety with silver thiosulphate preservative. When compared to alternative preservatives, silver thiosulphate enhanced solution absorption in all *Gypsophila* types **(Figure 1)**. This may be due to the antimicrobial properties and its ability to preserve the cut flower's internal sugar content of the cut flower by minimizing sugar loss, which increases the reactivity (Petridou *et al.*, 2001). Sugar is the gold key of floral energy sources as it has positive effects on many physiological activities and metabolic reactions, including vase life extension, inhibition of ethylene synthesis, and control of water uptake. There are many studies on sugar solutions for improving flower vase life, and effective sugar concentrations differ for different species (Kong *et al.*, 2021).

According to previous studies, (Abou El-Ghait *et al.*, 2012), silver thiosulphate was the most successful in prolonging the vase life and preserving the quality of roses. This current investigation supports these findings. The postharvest quality of the rose-cut flower pulsed with silver thiosulphate was enhanced, while the ethylene synthesis was suppressed. Furthermore, it has been established that the silver ion has bactericidal properties and inhibits the action of ethylene (Torre & Fjeld, 2001). Additionally, according to Al-Humaid (2004), silver thiosulphate increases vase life by 22% and enhances the quality of spikes in Gladiolus cultivars by enhancing the cut flower's solution uptake.

Table 1. Main effects of preservative solutions and varieties on solution uptake, water loss, and water balance of *Gypsophila* cut flowers

Treatments	Solution uptake (g)	Water loss (g)	Water balance (g)
	Variety		
Overtime	29.214	31.963^b	3.540^a
Magnet	29.124	32.863^a	2.914^b
Blancanieves	28.772	31.803^b	2.772^b
P-value	Ns	**	**
CV (%)	5.228	2.702	15.90
SE±	0.134	0.329	0.235
	Solution		
$AlSO_4$	26.553^c	29.691^c	3.621^b
STS	44.181^a	47.386^a	4.118^a
TOG-3	29.698^b	33.267^b	3.558^b
Sugar	23.658^d	27.254^d	2.051^c
Distil water	21.111^e	23.464^e	2.027^c
P-value	***	***	***
CV	5.228	2.702	15.90
SE±	4.047	4.115	0.433

*The main effects followed by different letters are significantly different, *** very highly significant.*

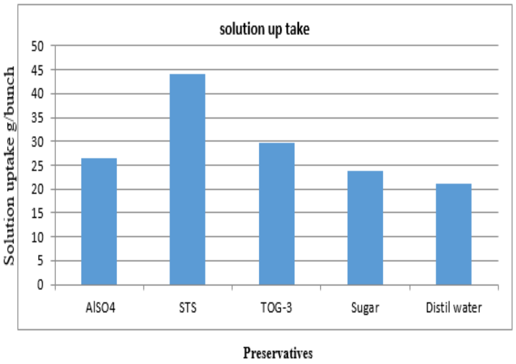
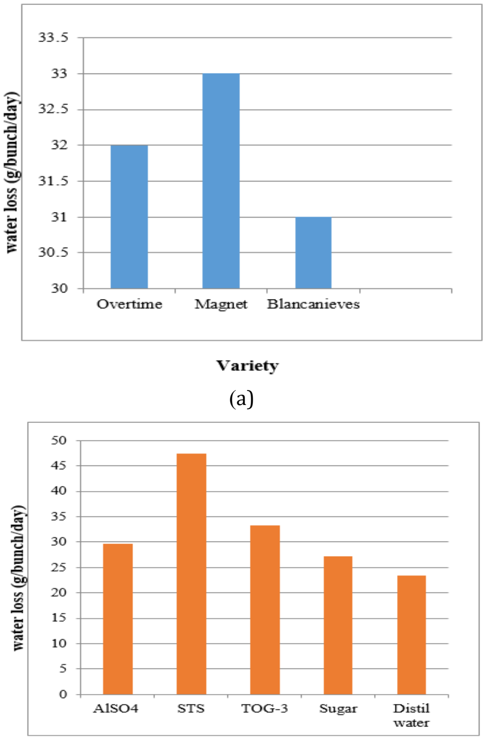


Figure 1. Effect of preservative solutions on solution uptake during the vase life of *Gypsophila*

Effect of floral preservatives on the water loss of Gypsophila varieties

The results of the analysis of variance indicated that the variety had a highly significant influence ($P < 0.01$) on the loss of the cut flowers, while the main effect of the preservative solution and its interaction with the *Gypsophila* variety was influenced very highly significantly ($P < 0.001$) **(Table 1)**. Compared to other preservatives, cut flowers stored in STS showed the highest rate of water loss. The *Gypsophila* variety magnet lost the most water over time **(Figures 2 and 3)**. When it came to the interaction effect, the treatment combination of the overtime variety and STS preservative recorded the lowest water loss, whereas the magnet variety maintained in the STS preservative produced the highest value. These results were statistically similar. The combination of overtime variety treatment and distilled water as the control preservative yielded the least water loss **(Table 1)**. The water loss from transpiration increased in *Gypsophila* flowers pulsed with STS until the seventeenth day of vase life, whereas water loss from pure water and sugar-pulsed cut flowers reduced after the third day. The present study has detected an increase in water loss on cut flowers given with STS. This could be attributed to the chemical's microbial action, which enhances the ability of cut flowers to absorb water. Cut stems lose water by transpiration via stomata and/or to a lesser extent through diffusion from leaves and floral organs. Trimmed stems lose water through stomata-mediated transpiration and/or, to a lesser extent, diffusion from leaves and floral organs (Taiz & Zeiger, 2006). When the cut stems are submerged in water, their fresh weight changes noticeably. This is mostly because of decreased water uptake caused by air embolism and microbial vascular blockage. It first rises as a result of the buds expanding and then falls as a result of the foliage or flower bud senescence (Singh & Tiwari, 2002). However, ethylene generated at the stem's cut end and the wounding reaction might cause xylem blockage, which lowers water absorption (Loubaud & van Doorn, 2004). As water uptake increases, the loss of water from the flowers also increases. Shokalu *et al.* (2018) reported that the combination solution of *Aloe vera* at 5.0% and sucrose at 4% showed the best result in water uptake, provided a percentage of maximum increase in open bracts, and gave the highest relative water content.



(a)

(b)

Figure 2. Effect of different preservative solutions on water loss during the vase life of *Gypsophila*

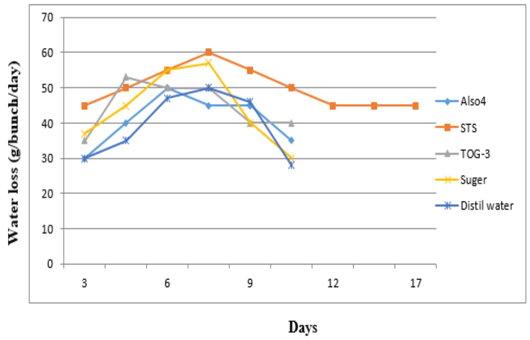


Figure 3. Effect of different preservative solutions on water loss during the vase life of *Gypsophila*

Effect of floral preservatives on the water balance of Gypsophila varieties

Analysis of variance showed that the preservative and variety and their interaction effect had a very high significant ($P < 0.001$) impact on the water balance of cut flowers. Compared to other solutions, the STS preservative proved to be the most successful in preserving the highest water balance (4.118 g). In the same vein, the *Gypsophila* overtime variant (3.54 g) maintained a higher water balance than the magnet (2.914 g). The highest water balance (5.2 g) in the interaction effect over time was observed in the *Gypsophila* types evaluated in STS, followed by a magnet (4.646 g) and Blancanieves (4.403 g) **(Table 1).** Compared to conventional preservative solutions, the STS preservative boosted water uptake and preserved the water balance of cut flowers for a longer period. Due to the chemical's microbial effect, which inhibits the growth and development of microorganisms in the xylem and so maintains better water uptake by flower stems, the STS typically retained the initial fresh weight and extended the vase life through increased water uptake and decreased weight loss (Kwon & Kim, 2000; Geng *et al.*, 2009). The flowers treated with STS exhibited better water balance than flowers treated with conventional treatments (Rabiza-Świder *et al.*, 2020).

Effect of floral preservatives on the fresh flower weight of Gypsophila varieties

Analysis of variance showed that the main effects as well as the interaction effects of variety and floral preservatives very highly significantly influenced the fresh weight of *Gypsophila* cut flowers **(Tables 2 and 3)**. The highest flower weight was recorded when the cut flower was treated in STS (14.556 g) as compared to TOG-3 (13.595 g), Sugar (12.724 g), $AlSO_4$ (12.678 g), and Distilled water (10.836 g). The highest amount of flower weight wear was recorded on the magnet variety **(Table 2)**. In the case of an interaction effect, the highest flower weight was recorded when the Magnet variety was maintained in STS preservative followed by Overtime. The lowest flower weight was recorded from the combination of the Blancanieves variety and distill water treatment **(Table 3)**. The present study is in agreement with (Singh & Tiwari, 2002); Pulsing rose cut flowers with STS reduced the frequency of bent necks of cut flowers and retained their fresh weight. Petal abscission is associated with leaf abscission, which is caused by the production of ethylene in cut flowers and causes weight loss. The appearance of petal abscission seems to be related to the total chlorophyll and soluble sucrose content of cut flowers. STS effectively inhibited petal abscission that occurred during the vase life, retarded the reduction of chlorophyll content, preserved carbohydrate contents, and inhibited ethylene. Darvishani and Chamani (2013) reported that pulsing the rose-cut flower in STS was effective in reducing flower weight loss. In general, STS most effectively sustained initial fresh weight longer in cut flowers. In this study, the number of days that flowers retained their initial fresh weight was also highest in flowers treated with STS.

Table 2. Interaction effect of preservative solution and variety on Solution uptake, Water loss, and Water balance of *Gypsophila* cut flowers

Preservative solutions	Variety	Solution uptake (g)	Water loss (g)	Water balance (g)
AlSO$_4$	Overtime	26.077^{efg}	30.193^{de}	4.080^{bc}
	Magnet	26.470^{ef}	29.606^{de}	3.450^{cd}
	Blancanieves	27.060^{de}	29.273^{ef}	3.333^{cd}
STS[Ag(S2O3) 2]3	Overtime	43.723^{b}	48.236^{a}	5.200^{a}
	Magnet	46.077^{a}	49.020^{a}	4.646^{ab}
	Blancanieves	42.743^{ab}	44.903^{b}	4.403^{ab}
TOG-3	Overtime	31.567^{c}	34.116^{c}	3.333^{cd}
	Magnet	29.157^{cd}	34.706^{c}	3.136^{de}
	Blancanieves	28.373^{de}	30.980^{d}	2.940^{def}
Sugar	Overtime	24.117^{fgh}	27.060^{g}	2.510^{efg}
	Magnet	23.137^{hij}	27.843^{fg}	2.306^{fgh}
	Blancanieves	23.723^{ghi}	26.860^{g}	1.953^{ghi}
Distil water	Overtime	21.567^{ij}	22.743^{i}	1.893^{ghi}
	Magnet	20.983^{j}	23.14^{hi}	1.603^{hi}
	Blancanieves	20.783^{j}	24.51^{h}	1.343^{i}
	CV	5.228	2.702	15.90
	P-value	***	***	***
	LSD	2.539	1.456	0.818

*The main effects followed by different letters are significantly different. *** = very highly significant*

Effects of floral preservatives on flower opening percentage (%) of Gypsophila varieties

The analysis of variance showed that the main effects as well as the interaction effect of floral preservatives and variety very highly significantly influenced in flower opening percentage of *Gypsophila* cut flowers **(Table 3)**. The cut flowers preserved in STS increased the opening percentage of flowers (97.556%) than the other preservative solutions TOG-3 (81.889%), Sugar (68%), AlSo$_4$ (64.111%), and distilled water (46.889%). The highest opening percentage of flowers was recorded on the variety magnet (95.867%) followed by over time (90.533%). All *Gypsophila* varieties tested in the present study generally recorded the highest flower opening percentage in the range of 98.333% to 96.767% when they were preserved in STS preservative, which was statistically similar **(Table 3)**.

According to Downs *et al.* (1988), silver thiosulfate, results in a good opening, delaying the senescence, and fading of flowers. The result is similar to the findings of (Hutchinson *et al.*, 2003), silver thiosulphate improved vase life and floret opening of cut flowers *Lilium longiflorum*, *Gypsophila*, and *Alstroemeria*. Reid *et al.* (1989) said in the post-harvest study of roses different concentrations of silver thiosulfate (STS) had significantly improved the opening period of cut roses. Likewise, the interaction of sucrose with STS also contributes significantly. In this study, STS was an effective preservative in the flower opening percentage than the other preservatives.

Table 3. Main effects of preservative solutions and varieties on flower fresh weight, flower full blooming day, vase life and Flower stem thickness of cut Gypsophila flowers

	Flower fresh weight (g)	Flower opening percentage (%)	Vase life (day)	Flower stem thickness (cm)
Variety				
Overtime	12.688^{b}	90.533^{b}	7.433^{ab}	2.0300
Magnet	13.884^{a}	95.867^{a}	8.466^{a}	1.9940
Blancanieves	12.062^{c}	88.667^{b}	6.733^{b}	2.1033
P–value	***	***	***	Ns
CV	4.915	4.872	8.328	15.776
SE±	0.534	2.157	0.211	0.032
Preservative Solutions				
Also	12.678^{c}	64.111^{d}	5.000^{c}	1.9433
STS	14.556^{a}	97.556^{a}	16.556^{a}	2.3356
TOG-3	13.595^{b}	81.889^{b}	6.333^{b}	2.0500
Sugar	12.724^{c}	68.000^{c}	4.333^{d}	1.8767
Distell water	10.836^{d}	46.889^{e}	3.333^{e}	2.0067
P–value	***	***	***	NS
CV	4.915	4.872	8.328	15.776
SE±	0.614	8.541	2.411	0.078

*The main effects followed by different letters are significantly different. NS = not significant, *** very highly significant.*

Effect of floral preservatives on flower vase life of Gypsophila varieties

The main effects and the interaction effect of preservatives and variety were very highly significantly ($P < 0.001$) influenced the vase life of the cut flowers of *Gypsophila*. Holding of *Gypsophila* cut flowers in STS recorded the longest vase life while the shortest was recorded in distilled water as a preservative. On the other hand, cut flowers of magnet variety recorded the longest (7.466 days) vase life, and the lowest vase life was recorded from Blancanieves (6.733 days) **(Table 3)**. All *Gypsophila* varieties treated with STS recorded the longest vase life ranging from 16 to 17 days, which were statistically similar **(Table 4)**.

Silver compounds act as antimicrobial agents to control the growth rate of bacterial populations and on the other side act as inhibitors of ethylene action, reducing ethylene production

(Reid *et al*., 1989). STS was the most effective preservative that prolonged the vase life of cut rose flowers. This may be due to the inhibition of ethylene action by STS by suppressing the binding of ethylene receptors and consequently resulting in retardation of flower senescence (Ichimura & Goto, 2002). The inhibition of the action of ethylene by STS has also prolonged the vase life of many cut flowers (Shokalu *et al*., 2018). According to Fahima and Inayatullah (2023), STS pulse treatments delay senescence and improve the post-harvest performance of flowers. STS is the most effective antibiotic effect against microorganisms that damage as well as block the xylem vessel of cut flowers, and reduce the bacterial populations in vase solution, to improve the vase life and quality of cut flowers (Nowak *et al*., 1990).

Effect of floral preservatives on flower stem thickness of Gypsophila varieties

Analysis of variance showed that the effect of preservative solutions, *Gypsophila* cut flower varieties, and their interactions on flower stem thickness of *Gypsophila* cut flowers was not significant **(Table 4)**. This might be due to the experiment being conducted after cut of the flower.

Table 4. Interaction effects of treatments preservative solutions and varieties on flower fresh weight change, flower full blooming day, vase life on cut *Gypsophila* varieties

Preservative solutions	Variety	Flower fresh weight (g)	Flower opening percentage	Vase life (day)	Flower stem thickness (cm)
$AlSO_4$	Overtime	11.683^{fg}	58.667^{e}	5.666^{cd}	1.890
	Magnet	12.076^{ef}	66.333^{d}	6.000^{cd}	2.053
	Blancanieves	11.570^{fg}	55.667^{e}	5.000^{de}	1.886
$STS[Ag(S_2O_3)^2]_3$	Over time	15.100^{a}	97.667^{a}	16.66^{a}	2.463
	Magnet	15.500^{a}	98.333^{a}	17.000^{a}	2.080
	Blancanieves	14.586^{ab}	96.667^{a}	16.000^{a}	2.463
TOG-3	Overtime	13.983^{bc}	81.667^{bc}	6.666^{c}	1.720
	Magnet	14.316^{abc}	84.000^{b}	10.666^{b}	2.020
	Blancanieves	13.646^{bcd}	80.000^{bc}	6.333^{c}	2.410
Sugar	Overtime	12.823^{de}	70.000^{d}	4.333^{ef}	1.890
	Magnet	13.333^{cd}	78.000^{c}	4.333^{ef}	1.760
	Blancanieves	12.763^{de}	67.667^{d}	4.333^{ef}	1.980
Distil water	Over time	10.763^{hg}	47.000^{f}	3.333^{fg}	2.186
	Magnet	11.253^{fg}	49.000^{f}	3.666^{fg}	2.056
	Blancanieves	10.176^{h}	44.667^{f}	3.000^{g}	1.776
	P-value	***	***	***	*not significant*
	CV	4.915	4.872	8.328	15.776
	LSD	1.0587	5.8426	1.045	0.538

*The main effects followed by different letters are significantly different. *** = very highly significant.*

CONCLUSION

The current study's findings unequivocally demonstrated how preservatives and cultivars affected several cut *Gypsophila* flower characteristics, such as solution uptake, water balance, water loss, fresh flower weight, and vase life. When it came to every aspect of the cut flowers, including the vase life, STS outperformed the other preservatives. In general, the STS-treated magnet variety of *Gypsophila* showed the greatest freshwater loss (49.02 g), solution uptake (46.007 g), and fresh weight (15.5 g) of the flowers, followed by overtime (15.1 g). With all evaluated *Gypsophila*, cultivars held in STS preservative, the longest vase life—16–17 days—and the highest percentage of flowers opened (98.333%) to (96.667%) were observed. Holding all varieties of the tested varieties in distilled water recorded inferior results in all parameters of cut flowers including vase life. Cut flowers of the Magnet variety of *Gypsophila* performed best in all aspects, followed by the overtime variety.

Silver thiosulphate preservative has prolonged the vase life and quality of cut flowers of the tested varieties of *Gypsophila*, which can be recommended as a preservative to prolong the shelf life and thus reduce postharvest losses in the farm around the study area. Further studies are also recommended to determine the optimum rate of silver thiosulphate.

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