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Effects of Floral Preservatives on The Extension of Vase Life and Quality of Tuberose

Ashrafun Nahar, Md. Harun Ar Rashid*, Most Tamanna Tasmim, Mst. Mukti Banu, and Mst. Fatema Tuz- Zahura

Department of Horticulture, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

***Corresponding author:** Md. Harun Ar Rashid; E-mail: harun_hort@bau.edu.bd

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An experiment was conducted to study the effects of preservative solutions on the extension of vase life of tuberose in the Postharvest Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from 1 August 2023 to 10 August 2023. The experiment consisted of two types of tuberoses viz. single (C_1) and double (C_2) and five preservative solutions viz., T_0= water (control), T_1= lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3= aspirin solution (0.03%), and T_4= sugar solution (5%). The two-factor experiment was carried out in a Randomized Complete Block Design with 3 replications. Results revealed substantial differences between tuberose types in respect of various parameters under study. Double tuberose performed higher total solution uptake (149.00 ml) and maximum vase life (11.0 days) and gave a lower number of opened and dried florets, compared to single type. There was significant variation among the treatment effects in respect of a number of opened and dried florets, total solution uptake (ml) and vase life. Considering all the parameters studied, it was concluded that double tuberose along with sugar solution performed better in respect of vase life extension and keeping the quality of tuberose compared to other treatments.

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Introduction

Tuberose (*Polianthes tuberosa*), a member of the Asparagaceae family, is a perennial, bulbous plant valued for its fragrant flowers and ornamental appeal. The name "tuberose" originated from the Latin term “tuberose,” referring to the plant's tuberous roots, which store nutrients and support its growth. Native to Mexico, it has been cultivated for centuries for its captivating fragrance and aesthetic appeal. Tuberose produces long spikes adorned with waxy, star-shaped white flowers, celebrated for their elegance and durability. Its aesthetic appeal is complemented by the longevity of its blooms, which can retain their beauty for days, even after being cut (Ramachandrudu & Thangam,2009). The flowers bloom during the evening, releasing a sweet, intense fragrance that attracts pollinators and adds to the plant's aesthetic and economic value. This unique flowering habit and aromatic property have earned tuberose a prominent role in gardens, floral arrangements, and religious offerings (Kutty et al., 2020). It has become an integral part of the perfume industry, ornamental gardening, and cultural rituals. It is grown extensively in tropical and subtropical regions, including India, Bangladesh, and parts of Africa and Southeast Asia, where it thrives under warm and sunny conditions (Mandal et al., 2023). In many countries, including Bangladesh and India, tuberose flowers are used in weddings, religious ceremonies, and festivals to symbolize purity and elegance (Ramachandrudu & Thangam,2009). The flower's scent is believed to have mood-enhancing properties and is often used in aromatherapy to induce relaxation and reduce stress. The importance of tuberose is not limited to its visual appeal. Besides this, one of the most significant contributions of tuberose lies in the production of essential oil, which is one of the most expensive floral oils in the world. The oil, extracted through processes like solvent extraction or enfleurage, is highly valued in the fragrance industry for its complex and long-lasting aroma. Its chemical composition includes volatile compounds such as methyl benzoate, benzyl alcohol, and eugenol, which give the oil its characteristic scent. The demand for tuberose oil, often referred to as "liquid gold," has made it a lucrative crop for farmers and industries alike (Bakkali et al., 2008).

Effective post-harvest management is critical for maintaining the quality and marketability of tuberose flowers. Addressing critical factors such as harvesting techniques, proper hydration, optimal storage conditions, and the strategic use of floral preservatives can significantly extend the vase life of tuberose, ensuring its freshness and premium quality for consumers Bhattacharjee (1999). These practices not only enhance the flower's commercial value but also minimize wastage, making it an economically viable choice for growers and traders in the floral industry. The application of floral preservatives (sugar solution, lemon juice, $CaCl_2$ solution, aspirin solution, and so on) has been widely studied for extending the vase life of cut flowers. The role of sugar, particularly sucrose, in maintaining flower hydration and metabolic function has been demonstrated in several studies across different flower species. One of the most well-documented effects of floral preservatives is on roses (Rosa spp.), where the combination of sucrose and an acidifying agent has shown remarkable results. Aryal et al. (2019) demonstrated that roses treated with a 3% sucrose solution combined with citric acid extended their vase life by up to 7 days compared to those in plain water. Halevy and Kofranek (1983) found that a solution containing sucrose, and an acidifier effectively slowed down stem elongation and prevented premature wilting of tulips. The study reported that the vase life of tulips treated with floral preservatives was extended by 4-5 days, with the flowers showing improved hydration and color vibrancy. The investigation of Roshikanta (2021) highlighted that the solution not only enhanced hydration but also helped delay wilting and petal senescence, allowing chrysanthemums to remain fresh for up to 7 days longer than those in plain water. As the large-scale cultivation of tuberose is gaining popularity in Bangladesh, the present study was conducted to evaluate the effect of several preservatives on the post-harvest quality parameters and vase life of two different types of tuberoses.

Materials and Methods

Experimental location and period of the study

The goal of the current experiment was to find the optimal treatment combination for maintaining flowers for long-term preservation. It was carried out in the Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh, from August 1 to August 10, 2023.

Experiment Framework

The experiment used two components: Factor A, two types of tuberoses (C_1=single and C_2=double), and Factor B, five preservative solutions (T_0=water, which served as the control), T_1= sugar solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3= aspirin solution (0.03%), and T_4= lemon juice solution (5%). Three replications of the two-factor experiment were used in the Completely Randomized Design (CRD) layout. The tuberose spikes were bought from the Flower Shop (Mala Store) located in Mymensingh town.

Methods for preparing preservative solutions Control (Tap water)

Tuberose spikes were selected and placed in 15 vases containing Tap water and kept in the laboratory at room temperature.

Lemon juice solution (5%)

One liter of water was infused with fifty milliliters of lemon juice to create the solution. 15 flowers of spikes were selected and placed in a lemon juice solution (200ml) and kept in the laboratory at room temperature.

Sugar solution (5%)

Fifty-gram sugar was diluted in one liter of water. 15 tuberose spikes were selected and placed in 15 vases containing sugar solution (200 ml) and kept in the laboratory at room temperature.

Aspirin solution (0.03%)

0.03 gm aspirin tablet was mixed with one liter of water to prepare the solution. 15 flowers were selected and placed in 15 vases containing aspirin solution and kept in the laboratory at room temperature.

$CaCl_2$ solution (0.05%)

To create the solution, 0.05 grams of calcium chloride was mixed in a liter of water. Then 15 flowers were selected and placed in 15 vases and kept in the laboratory at room temperature.

Methods of studying different parameters

Number of opened florets

By counting every two days, it was possible to determine how many opened florets of tuberose spikes were affected by various preservatives.

Number of dried florets

By monitoring on two separate days, the number of dried florets affected by various preservatives was determined.

Total solution uptake (ml)

The amount of solution that was still present 12 days after storing was used to compute the total solution absorption (ml). Evaporation of water was controlled by aluminum foil paper covering the top of the pot.

Vase life

By tracking the number of days, it took to dry all the florets after harvest, researchers were able to determine how different preservatives affected the vase life of flowers.

Statistical analysis

The MSTAT computer application was used to statistically assess the data acquired from experiments on various parameters. The analysis of variance for each character was completed by the F variance test after the average values for all the variables were computed. The Least Significant Difference (LSD) test was used to determine the significance of the difference between two sets of averages at 1% levels of chance (Gomez and Gomez, 1984).

Results and Discussion

Number of opened florets

The number of opened florets of tuberose was influenced significantly because of distinct types of tuberoses. The maximum number of opened florets (8.80) was obtained from the single type (C_1). Double tuberose (C_2) was determined to have the fewest number of opened florets (7.27) (Table 1). Sigma et al. (2018) found that single varieties demonstrated a 10%–15% higher floret opening rate. This can be attributed to their more efficient water uptake and availability of carbohydrates for metabolic processes. Kumar et al. (2012) noted that the dense floral structure of double varieties imposes higher energy demands, which, coupled with compromised water uptake, limits floret opening.

Table 1. The impact of types on the number of open florets of tuberose at various DAS

Types	No. of florets open at different DAS				
	2	4	6	8	10
C_1	4.80	6.40	8.40	8.73	8.80
C_2	4.37	5.07	5.67	6.80	7.27
$LSD_{0.05}$	0.64	0.56	0.71	0.59	0.86
$LSD_{0.01}$	0.87	0.76	0.97	0.80	1.17
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability; C_1 = single, C_2= Double

Postharvest treatments exerted a significant effect on the opening of florets during storage. Overall opening of florets trended increased with the progress of storage duration, the lowest number of opening of florets (9.33) was observed in 5% sugar solution and the highest number of opening florets (6.87) was observed in the control (tap water) treatment at 10 days after storage (Table 2). Sugar is an osmotically active chemical that aids in maintaining the turgidity of the growing corolla and aids in the development of flowers and openings. Varu & Barad (2008) found that the application of a 3% sucrose solution extended vase life by 3–4 days, with single-flowered varieties The sucrose solution provides a readily available source of energy, essential for maintaining the aesthetic quality and metabolic function of the flowers.

Table 2. Influence of various after-harvest procedures on the quantity of tuberose florets at various DAS

Postharvest treatments	No. of florets open at different DAS				
	2	**4**	**6**	**8**	**10**
T_0	7.17	7.50	8.67	8.83	9.33
T_1	3.50	4.50	4.50	5.50	6.87
T_2	5.17	5.67	7.50	8.17	8.67
T_3	5.0	5.50	6.50	7.21	8.50
T_4	6.17	6.29	8.17	8.33	9.0
$LSD_{0.05}$	1.01	0.88	1.12	0.93	1.36
$LSD_{0.01}$	1.37	1.20	1.53	1.27	1.85
Level of significance	**	**	**	**	**

** = Acceptable at a 1% level of chance

T_0 = (Control, tap water), T_1 = lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3 = aspirin solution (0.03%), T_4 = sugar solution (5%)

The quantity of opened florets was greatly impacted by the combined effects of tuberose type and several postharvest treatments. The use of the pair of single (C_1) with control (tap water) treated yielded the highest number of opened florets (10.23). The treatment combined with double (C_2) with 5% syrup produced the least number of exposed florets (6.17) (Table 5). The tendency of florets opening was slower at the initial part of storage but drastic changes in florets opening were observed during the 6-8th day after storage.

Number of dried florets

A significant effect was found in dried florets by different varieties. The number of dried florets was lowest in the case of double type (C_2) (8.53) compared to single(C_1) (9.20) (Table 3).

Table 3. Effectiveness of types on floret drying amount at various DAS

Type	No. of florets dried at different DAS			
	4	**6**	**8**	**10**
Single (C_1)	7.13	8.87	8.93	9.20
Double(C_2)	4.00	6.27	7.47	8.53
$LSD_{0.05}$	0.57	0.75	0.50	0.70
$LSD_{0.01}$	0.78	1.02	0.68	0.95
Level of significance	**	*	NS	**

** = Significant at 1% level of probability; C_1 = Single, C_2= Double

The present investigation's postharvest procedures substantially impacted the dried florets. The minimum number of dried florets (3.67) was observed in a 5% sugar solution at 10 DAS, and the maximum number of dried florets (8.0) was observed in the control solution (Table 4). Since sugars are the primary food supply for flowers and are necessary to power all hormonal and physiological processes once flowers separate from their mother plants, they play a significant role in maintaining the high standards of cut flowers.

Table 4. Effect of different postharvest treatments on the quantity of dried florets of tuberose at different DAS

Postharvest treatments	No. of florets dried at different DAS			
	4	**6**	**8**	**10**
T_0	8.00	8.15	9.75	10.17
T_1	3.67	5.51	6.67	8.17
T_2	6.00	6.52	8.76	9.15
T_3	5.17	6.17	7.07	7.53
T_4	6.50	7.83	9.55	9.85
$LSD_{0.05}$	0.91	1.18	0.79	1.10
$LSD_{0.01}$	1.24	1.61	1.08	1.50
Level of significance	**	**	**	**

** = Acceptable at a 1% level of chance
T_0 = (Control, tap water), T_1 = lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3 = aspirin solution (0.03%), T_4 = sugar solution (5%)

On dried florets, the cumulative impact of various types and postharvest treatments was discovered. Double variety(C_2) showed the lowest number of dried florets (5.33) with the treatment combination of 5% sugar solution(T_4). When compared with the control (T_0) treated 10 DAS, the single (C_1) was shown to have a maximum amount of dried out florets (13.0) (Table 5).

Table 5. The combined impact of tuberoses and various postharvest therapies on the quantity of opened and desiccated florets at various DAS

Treatment combinations	No. of open florets at different DAS					No. of florets dried at different DAS			
	2	**4**	**6**	**8**	**10**	**4**	**6**	**8**	**10**
C_1T_0	7.00	7.33	8.33	10.33	11.67	10.33	10.67	11.33	13.00
C_1T_1	5.33	6.67	7.67	8.33	10.23	7.00	8.33	9.00	11.00
C_1T_2	4.67	5.00	7.00	9.67	8.53	6.67	7.00	8.31	8.92
C_1T_3	3.33	5.73	6.59	7.97	7.88	5.33	6.27	7.37	7.87
C_1T_4	4.33	4.76	5.67	6.76	8.13	4.43	5.17	7.00	8.33
C_2T_0	3.00	4.33	5.72	7.00	7.23	3.33	4.27	5.33	6.11
C_2T_1	2.12	3.33	4.83	5.67	6.17	2.33	3.67	4.76	5.33
C_2T_2	5.67	6.33	5.33	6.32	8.61	8.00	8.76	9.33	12.00
C_2T_3	5.00	6.67	7.00	7.71	7.00	7.67	8.33	9.13	11.37
C_2T_4	5.67	6.47	7.17	6.52	9.33	6.67	7.00	8.72	12.13
$LSD_{0.05}$	1.43	1.24	1.59	1.32	1.92	1.28	1.67	1.12	1.55
$LSD_{0.01}$	1.94	1.70	2.16	1.80	2.61	1.75	2.28	1.53	2.12
Level of significance	**	**	**	**	**	**	**	**	**

** = Significant at 1% level of probability; C_1 = Single, C_2= Double
T_0 = (Control, tap water), T_1 = lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3 = aspirin solution (0.03%), T_4 = sugar solution (5%)

Total solution uptake by tuberose

Significant variation was observed in total solution uptake by different varieties of tuberose. The lower total solution uptake was in single (C_1) (135 ml) and the higher solution uptake was in double (C_2) (149.00 ml) (Figure 1).

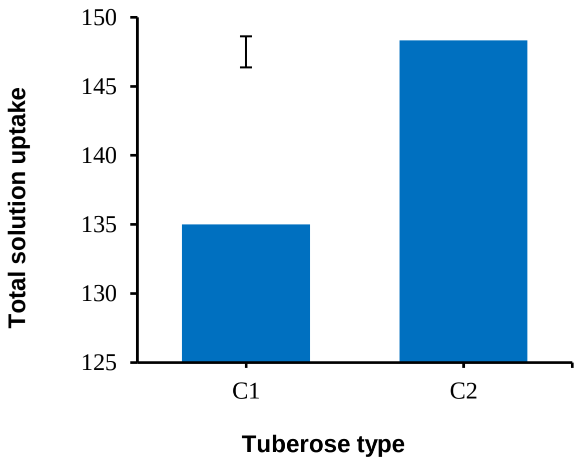

Figure 1. Principal impacts of variation on overall solution uptake at various days after storage (DAS). Vertical bar indicates significantly LSD value at 1% level; C_1 = Single, C_2= Double

Significant variation was observed in total solution uptake in tuberose by different treatments. The total solution uptake is higher in 5% sugar solution (161.0 ml) and lower in the control solution (121.0 ml) (Figure 2). Sucrose aids in preserving turgidity and water balance. Sucrose solution (3%) Effective in maintaining water uptake and turgidity in tuberose spikes, resulting in a vase life extension of up to 50% (Hasna et al., 2021). Kumar et al (2022) found sucrose treated flowers absorbed 25–40% more water compared to untreated flowers.

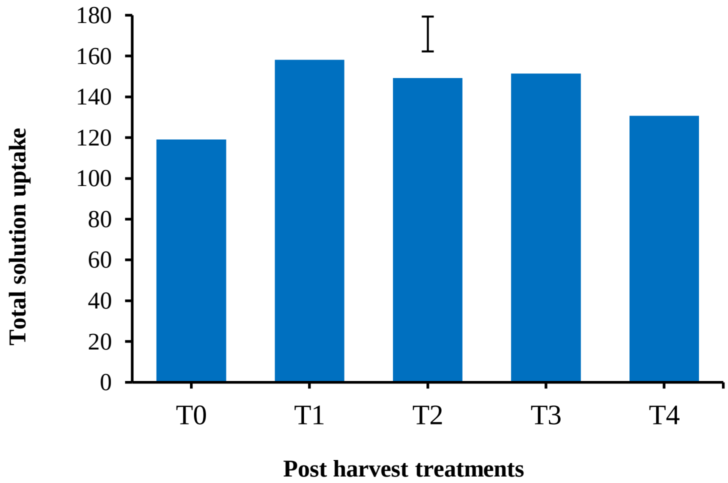

Figure 2. Different postharvest treatments' main effects on total solution uptake at various days after storage (DAS) are shown in the table below. LSD is represented by vertical bars with a 1% level of importance. T_0 = (Control, tap water), T_1 = lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3 = aspirin solution (0.03%), T_4 = sugar solution (5%)

The combination effect of various types and treatments had a substantial impact on the overall solution absorption. Results showed that the highest total solution uptake (162.23ml) was observed in C_2T_1 and the lowest percentage of total solution uptake (108.67ml) was observed in C_1T_0 (Figure 3).

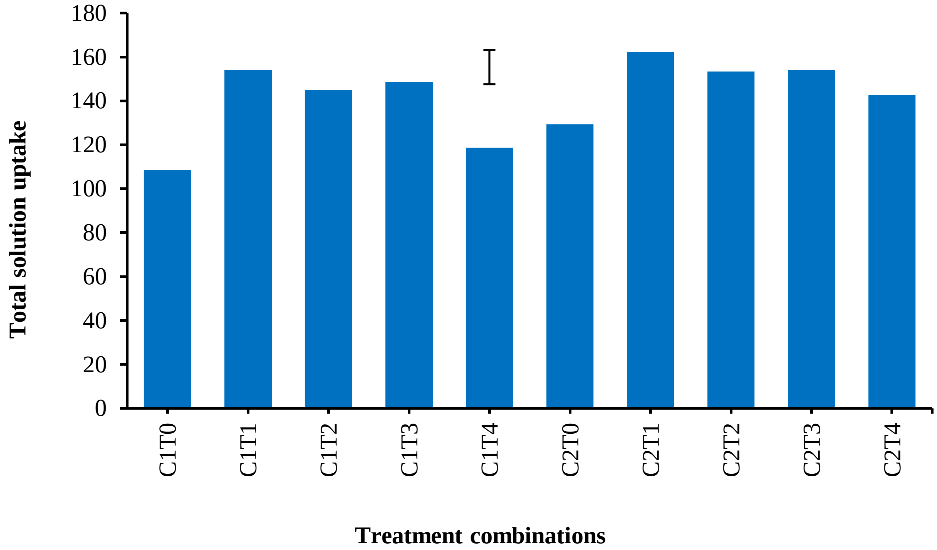

Figure 3. The interaction effect of variety and postharvest treatments on total solution uptake by rose. The vertical bar displays the LSD with a 1% degree of probability. ** = Significant at 1% level of probability; C_1 = Single, C_2= Double.T_0 = (Control, tap water), T_1 = lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3 = aspirin solution (0.03%), T_4 = sugar solution (5%) Vase life

Different varietals have a considerable impact on tuberose longevity in the vase. Single tuberose (C_1) showed the lower vase life was (7.5 days) whereas double variety (C_2) showed higher vase life (11.00 days) (Figure 4).

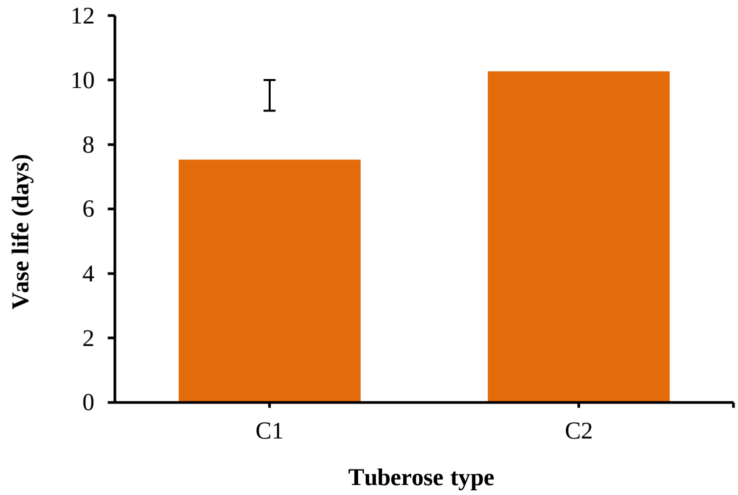

Figure 4. Principal impact of variation on vase life at various days after storage (DAS). The vertical bars indicate LSD value at 1% level. C_1 = Single C_2 = Double

Different preservatives had a substantial impact on the vase life of tuberoses. In a 5% sugar solution, the longest vase life was obtained (11.8 days), and the shortest vase life was reported (8.13 days) in the untreated treatment (Figure 5). The longer vase life may be a result of the sucrose in the vase solution having an impact on the water balance in the cut tuberose flowers. Anzum et al. (2001) reported 3% Sucrose significantly extended the vase life of tuberose flowers by providing an external energy source. The addition of sucrose helped maintain the turgidity and freshness of the flowers. The chemical treatments not only increased the vase life but also maintained the fragrance, structural integrity, and aesthetic quality of the flowers.

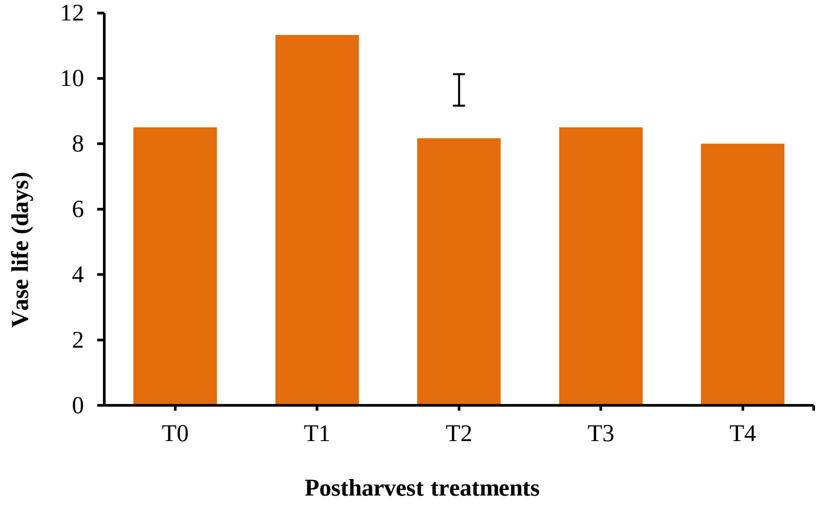

Figure 7. The primary outcomes of various post-harvest procedures on vase life at various DAS. LSD is represented by vertical bars with a 1% level of significance. T_0 = (Control, tap water)**,** T_1 = lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3 = aspirin solution (0.03%), T_4 = sugar solution (5%)

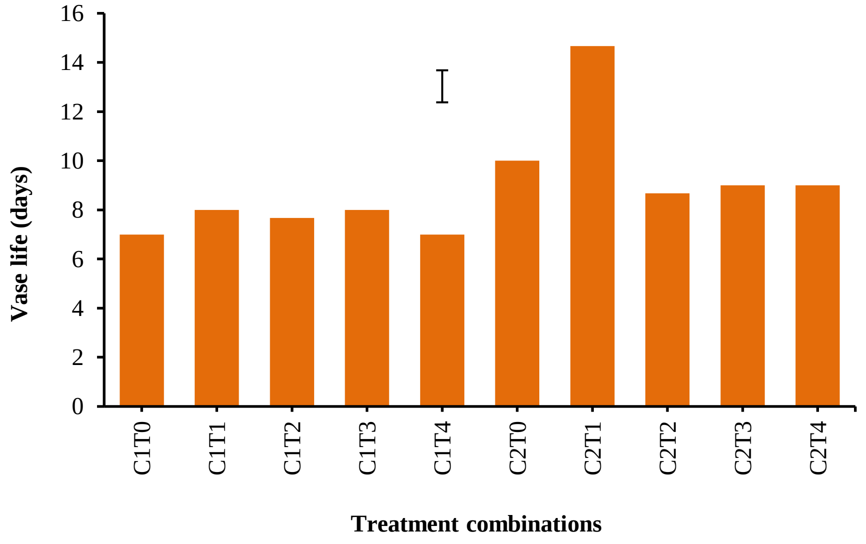

Figure 6. Combined effects of various postharvest treatments and types on vase life at various storage time points. Vertical bar: 1% degree of significance for LSD. ** = Significant at 1% level of probability; C_1 = Single, C_2= Double.T_0 = (Control, tap water), T_1 = lemon juice solution (5%), T_2= $CaCl_2$ solution (0.05%), T_3 = aspirin solution (0.03%), T_4 = sugar solution (5%)

The combined effect on vase life of tuberose type was also significant due to different varieties and postharvest treatments. The greatest length of vase life (10.00 days) and minimum vase life (7.00 days) were found in V_1T_4 and V_2T_0, respectively (Figure 8). The germicides keep hazardous microorganisms under control and avoid clogging the conducting tissues, while the carbohydrates provide a respiratory substrate.

Conclusion

The current study examined the effects of types and different preservative solutions to increase the vase life of two types of tuberoses. It was carried out in the Department of Horticulture's laboratory at Bangladesh Agricultural University, Mymensingh, Bangladesh. Based on the findings of this experiment, it was found that various treatments behaved considerably in terms of lengthening the vase life of tuberose florets. Most treatments significantly differed in their ability to prolong the vase life of spikes. The experimental result revealed that combining 5% sugar solutions treatment with double tuberose variety was shown the best performance to extend vase life. Therefore, the combined application of 5% sugar solutions along with double tuberose type was found to be better in respect of the extension of vase life and quality of tuberose.

Conflict of interest

The authors did this research and wrote the article and there is no conflict of interest with other people.

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