EFFECT OF SUCROSE AND CITRIC ACID ON POSTHARVEST QUALITY AND VASE LIFE OF GERBERA (cv. hybrid mix) CUT FLOWERS

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ABSTRACT

This study was aimed at determining the effects of different preservative solutions, on the quality and vase life of cut *Gerbera jamesonii* flower (cv. hybrid mix). In nine different treatments, cut flowers were placed in glass jars containing solutions that included 50 ppm and 100 ppm concentration of Citric Acid, as well as 40 g/L and 60 g/L concentration of Sucrose; each alone and in combination with one another, along with the control. Parameters like fresh flower weight, water uptake, flower diameter, stem bending, and vase life were recorded on the basis of 1, 3, 5, 7, 9, 11 days (storage duration). The results showed that highest value of water uptake, fresh weight, flower diameter and flower vase life, was recorded using solution of 100 ppm Citric acid + 60g/L Sucrose, followed by solution of 100 ppm Citric acid. Flowers treated with distilled water (control) showed lowest value of water uptake, fresh weight, flower diameter, and flower vase life. The results showed that using sucrose and citric acid in preservative solutions had a significant effect on the quality and vase life of cut *Gerbera jamesonii* flowers. The overall quality and vase life of flowers with no preservative solutions significantly decreased in comparison to the ones, which were treated with preservative solutions.

Keywords: *Gerbera jamesonii*, ornamental plants, citric acid, sucrose, vase life

INTRODUCTION

Gerbera (*Gerbera jamesonii*) belongs to Asteraceae, which is the biggest family of flowering plants. It is popular for its large flowers, vibrant colors, and lovely appearance. It is among the top ten in-demand cut flowers in the world. According to the global trends in the floriculture industry, it holds fourth place among cut flowers (Choudhary and Prasad, 2000). It is in quite considerable demand in the international flower market. Gerbera daisies usually flower from late spring through autumn in the garden, and their blossoms make long-lasting cut flowers. The blooms are attractive and suitable for all types of floral arrangements. *Gerbera jamesonii* typically grows 6 to 18 inches tall. In addition to floral arrangements, Gerbera is widely used in bouquets and in making dry flower crafts. The cut flowers have an extended vase life, which usually fetches them premium prices in the market.

Gerbera jamesonii L. cv. hybrid mix is a commercially important cultivar of gerbera. Its potential in Pakistan, as a cut flower is widely increasing. Gerbera may become a valuable source of foreign exchange for Pakistan if grown on a commercial scale in the coming future. Gerbera is a much more valuable cut flower and potted plant than recognized because of its diversified characteristics, ability to propagate by seed, minimal labor requirements, and rapid growth.

The distinctive inflorescence of Gerbera daisy, generally measuring 8–12 cm in diameter, has star-shaped, ray floret ligulae that are white or shades of yellow, orange, or red, surrounding a yellow or black colored center of disc florets. This inflorescence is supported by a long, leafless, and upright scape (Wernett et al., 1996).

A critical aspect of the postharvest quality of cut flowers is their longevity. Researchers have investigated and discussed postharvest longevity in cut flowers, including gerbera, and concluded that it is actually not the length of lasting quality in itself that is the aim of post-harvest longevity, but the satisfaction of the consumer (Buys, 1978). Vase life is frequently used as an indicator of postharvest longevity in cut flowers. It is usually determined by the overall number of days from harvest until floral senescence (wilting) occurs. Flowers' vase life is critical in defining the crop's value.

The main post-harvest problem of cut gerbera flower along with wilting of the flower is stem break (Wilberg, 1973). Neck bending or stem break are the basic terms used to describe the sudden bending of the stem in cut gerberas. This type of premature senescence contrasts with normal senescence. In gerbera, normal senescence is identified as proper wilting and petal curling, which is the condition that occurs when the ligulae of an inflorescence on an upright stem have visibly lost their turgidity.

Cut Gerbera flowers are very prone to microbial contamination around the stem end in the preservative solution (Balestra et al., 2005; Liu et al., 2009). Microbial contamination is usually the cause of stem end blockage, which leads to wilting (Balestra et al., 2005). Other factors that affect postharvest losses include water uptake, mineral elements, water imbalance caused by bacteria within the xylem of cut flowers, and storage temperature after harvest and during handling (Ferrante et al., 2007).

Cut gerbera (*Gerbera jamesonii*) flowers are quite prone to microbial contamination, which can lead to a short vase life. Adding chemical preservatives to vase solution is usually recommended for extending the vase life of flowers. Most preservatives used in flowers consist of carbohydrates, growth regulators, germicides, ethylene inhibitors, and a few mineral compounds (Nowak and Rudnicki, 1990). Chemical Preservatives, like citric acid, aluminum sulphate, boric acid, and ascorbic acid are used for improving the vase life of cut flowers (Muhammed et al., 2001).

Sucrose is very commonly used in floral preservative solutions, it acts as a food source for respiratory substrate. It slows down the degradation of proteins and improves the water balance. Treating flowers with solutions containing sucrose (5-15%) has been shown to improve the vase life of Carnation and Gladiolas sp. (Mor et al., 1981). Sucrose antagonizes the effect of ABA, which usually supports senescence (Halevy and Mayak, 1979). (Khenizy, 2000) found that carnation cut-flowers were most effective in maintaining the pigment level in flower petals treated with sucrose + 8-HQC +citric acid.

Some organic acids such as salicylic acid (SA), citric acid, malic acid, and ascorbic acid play important roles in extending the postharvest longevity of cut flowers (Jin et al., 2006). Organic acids are a good source of energy for cells and are used in the respiratory cycle (Da Silva, 2003; Darandeh and Hadavi, 2012). An important role is played by citric acid in iron transport. It also has positive effects on the vase life of cut flowers (Darandeh and Hadavi, 2012). Adding citric acid improves flower longevity by reducing the overall pH of the solution and controlling microbial functions in the vase solution (Nowak and Rudnicki, 1990). Citric acid has been effective in increasing the postharvest life of cut flowers including Lilium and Tuberose (Eidyan, 2010; Darandeh and Hadavi, 2012). An important role has been played by acidic sucrose in extending the vase life, providing food for cut flowers, and stopping the growth of microorganisms inside the solution (Mehraj et al. 2013). Therefore, in our study, we used different sucrose and citric acid concentrations to prolong the vase life and maintain the quality of cut *Gerbera jamesonii* flowers.

MATERIALS AND METHODS

Experimental site and sample collection

The present study was conducted at the Department of Horticulture Research laboratory of The University of Agriculture Peshawar in late spring, 2022. The *Gerbera jamesonii* (cv. hybrid mix) cut flowers were harvested from the Ornamental nursery of Agriculture University Peshawar early in the morning at 60 cm length. They were directly stood in a water bucket and were transported to the postharvest laboratory 2 hours after harvesting. Buckets were covered with a plastic film wrap in order to minimize the loss of moisture during transportation. Stems were re-cut under 4°C water to ~40 cm length to remove air embolism after being bought to the laboratory. The flowers were selected for uniformity of color size, and freedom from any defects before being used. The flowers were placed in glass jars containing 250 ml of different chemical preservative solutions, with distilled water used as a control treatment, and kept in the laboratory at room temperature (25 ± 2°C) for 11 days; 85 – 90 % RH and continuous lighting with fluorescent lamps 1000 lux.

Experimental Design and Treatment Factors

The study was implemented to assess the effect of different concentrations of preservative solutions on the quality and vase life of *Gerbera jamesonii* (cv. hybrid mix) cut flowers. Treatments included concentrations of 50 ppm and 100 ppm of Citric Acid, as well as 40 g/L and 60 g/L of Sucrose; each alone and in combination with one another, along with the control treatment. The experiment design was completely randomized (CRD) with a total of nine treatments with each treatment replicated three times. The flower vase life and flower quality were assessed on the basis of 1, 3, 5, 7, 9, and 11 days of storage duration. The end of vase life is defined by considering the stem bending and visible wilting, with an angle of more than 90°. The following factors were taken, and their effects on the flower vase life and quality were observed.

Factor A: (Preservative Solution Treatments)

Factor B: (Storage Duration Days)

Data Recorded

The data were recorded on the following parameters: fresh weight (g), water uptake (ml), flower diameter (cm), stem bending, and vase life. The fresh weight data were recorded with the help of a weight balance. Average daily water uptake was determined by the formula: water uptake rate (g/stem/day) = (St-1 – St)/2; where St is the weight of vase solution (g) at t = days 1, 3, 5, 7, 9, 11; and St-1 is the weight of vase solution (g) on the previous day. The flower diameter was calculated with the help of a Vernier caliper.

The stem bending in gerberas was evaluated by Calikle and Reed (2002) method. The curvature of the scape was measured using a protractor and expressed with respect to the angle on the day of harvest (1st storage day). The gerberas were rated on the respective storage duration on a scale of 1 to 5. With 1 for bending up to 15°, 2 for bending between 15° and 25°, 3 for bending between 25° and 65°, 4 for bending between 65° and 90° and 5 for flowers that bent more than 90°. The flower stems in which the upper part exhibited an angle of more than 45° were considered bent. The average vase life of gerbera cut flowers was counted from the day the stems were transferred to the holding solutions, and was assessed to be finished when the cut flowers lost their ornamental display value (underwent a color change, lost turgidity, and wilted). The vase life of an individual cut gerbera flower ended when it showed high amounts of petal curling and neck bending.

Statistical Analysis

Data were analyzed by means of two-way analysis of variance (ANOVA) through "Statistix 8.1" software. The difference between means was compared by using the least significant difference (LSD) at 5% probability with the help of the computer software program STATISTICA-V. 8.1.

RESULTS AND DISCUSSION

Fresh weight (g)

Mean data regarding the fresh weight of *Gerbera jamesonii* measured in grams, is presented in Table 1. The results were significant for the fresh weight of flowers for treatments and storage duration. The results were not significant for interaction between treatments and storage duration. For preservative treatments, the highest fresh weight (7.61 g) was observed in 100 ppm Citric Acid + 60 g/L Sucrose treatment (T9). Meanwhile, the lowest fresh weight (6.5 g) was observed in 50 ppm Citric acid + 60 g/L Sucrose treatment (T7). During storage duration, the fresh weight decreased with storage duration increasing. For storage duration, the highest gerbera fresh weight (8.5 g) was recorded on day 1, and the lowest fresh weight (4.5 g) was noted on day 11.

The higher the fresh weight of the flower, the better it is at retaining water, and thus, maintaining freshness. The results are in agreement with (Amariutei et al., 1985) who stated that the fresh weight of the inflorescences, the relative turgor, and vase life recorded higher values in the chemically preserved inflorescences than those that were not preserved. The flower weight expresses the freshness of a flower, flower senescence and flower longevity. (Soad et al., 2011).

Table 1: Fresh weight of flowers (g) affected by different levels of preservative solutions during storage

Treatments (Preservative solutions)	Storage Duration (Days)						Mean
	S1	S2	S3	S4	S5	S6	
T1	8.66	8.66	7.66	7.66	5.66	4.66	7.16bc
T2	8.33	8.33	7.33	7.33	5.33	4.33	6.83cde
T3	8.66	8.66	7.67	7.66	6.00	5.00	7.27ab
T4	8.67	8.66	7.66	7.33	5.33	4.67	7.05bcd
T5	8.33	8.33	7.33	7.33	5.33	4.00	6.77de
T6	8.67	8.66	7.33	7.66	5.33	4.33	7.00bcd
T7	8.00	8.00	7.00	7.00	6.00	4.00	6.50e
T8	8.33	8.33	7.3	7.66	5.33	4.3	6.88cd
T9	9.00	8.66	8.00	7.33	5.33	6.00	7.61a
Mean	8.51a	8.48a	7.48b	7.44b	5.55c	4.59d	

LSD ($P \leq 0.05$) for storage = 0.27
LSD ($P \leq 0.05$) for treatment = 0.33

Water uptake (ml)

Mean data regarding water uptake of *Gerbera jamesonii* measured in ml, is presented in Table 2. The results were significant for the water uptake of flowers for treatments and storage duration. The results were not significant for interaction between treatments and storage duration. For treatments, the highest water uptake (11.1 ml) was observed in 100 ppm Citric Acid + 60 g/L Sucrose treatment (T9). Meanwhile, the lowest water uptake (9.2 ml) was observed in 50 ppm Citric Acid + 60 g/L Sucrose treatment (T7).

During storage duration, the water uptake increased with storage duration increasing. For storage duration, the highest water uptake (12.2 ml) was recorded on day 11, and the lowest water uptake (6.8 ml) was noted on the day 1.

The higher the water uptake of the flower, the better it is at retaining water, and thus, maintaining its quality. Therefore, our results showed that flowers in preservative treatments above maintained their freshness for the longest time among all the other experimental units. The results in agreement with those of (Rogers, 1973) who stated that sucrose is quite helpful in maintaining the turgidity and balance of water. Hence, adding sucrose to the holding solution might have led to an increase in the uptake of the holding solution.

Table 2: Water uptake of flowers (ml) affected by different levels of preservative solutions during storage

Treatments (Preservative solutions)	Storage Duration (Days)						Mean
	S1	S2	S3	S4	S5	S6	
T1	6.33	8.33	8.33	10.66	12.00	12.33	9.66c
T2	7.33	9.33	8.00	12.00	13.33	13.33	10.55b
T3	7.66	9.66	9.00	12.00	13.66	13.33	10.88ab
T4	6.33	8.33	8.00	10.66	11.33	11.33	9.33cd
T5	6.67	8.33	7.33	11.00	12.00	12.00	9.55cd
T6	6.67	8.66	8.00	10.66	11.33	11.33	9.44cd
T7	5.67	8.33	8.00	11.00	11.00	11.33	9.22d
T8	7.33	8.66	7.00	11.33	11.33	11.33	9.50cd
T9	8.00	10.00	9.00	12.66	13.33	13.66	11.11a
Mean	6.89e	8.85c	8.07d	11.33b	12.14a	12.22a	

LSD ($P \leq 0.05$) for storage = 0.34

LSD ($P \leq 0.05$) for treatment = 0.42

Flower Diameter (cm)

Mean data regarding flower diameter of *Gerbera jamesonii* measured in centimeters with the help of a Vernier caliper, is presented in Table 3 below. The results were significant for flower diameter of flowers for treatments and storage duration. The results were also significant for interaction between treatments and storage duration. For treatments, the highest flower diameter (8.5 cm) was observed in 100 ppm Citric acid + 60 g/L Sucrose treatment (T9) followed by (8.4 cm) in 100 ppm Citric Acid (T3). Meanwhile, the lowest flower diameter (7.3 cm) was observed in 40 g/L Sucrose treatment (T4). During storage duration, the flower diameter decreased with storage duration increasing. For storage duration, the highest flower diameter (9.4 cm) was recorded on day 1, and the lowest flower diameter (5.7 cm) was recorded on day 11. For interaction the maximum flower diameter (9.6 cm) was recorded on day 1 under 100 ppm Citric Acid + 60 g/L Sucrose treatment (T9), and the minimum flower diameter (5.0 cm) was recorded on day 11 under 40 g/L Sucrose treatment (T4).

The higher the flower diameter of the flower, the better it is at maintaining its quality. Therefore, our results are in agreement with (Mehdikhah et al., 2016) who stated that observing the effect of citric acid, salicylic acid and ascorbic acid on the flower diameter discovered that the maximum flower diameter-increasing index was found in cut flowers treated with 100 mg l-1 citric acid.

Table 3: Flower diameter (cm) affected by different levels of preservative solutions during storage

Treatments (Preservative solutions)	**Storage Duration (Days)**						**Mean**
	S1	S2	S3	S4	S5	S6	
T1	9.66	8.33	7.00	7.33	6.66	5.33	7.38c
T2	9.66	9.00	8.66	8.00	6.33	5.33	7.83b
T3	9.66	9.00	8.33	9.00	8.00	6.66	8.44a
T4	9.33	8.33	7.00	7.66	6.67	5.00	7.33c
T5	9.33	8.66	7.66	7.33	6.33	6.00	7.56bc
T6	9.66	8.33	7.33	7.33	6.33	5.66	7.44c
T7	9.00	8.33	7.66	7.33	7.00	5.00	7.44c
T8	9.33	8.66	7.66	7.33	6.00	6.00	7.44c
T9	9.66	9.66	8.66	8.66	7.66	7.00	8.55a
Mean	9.48a	8.70b	7.77c	7.77c	6.77d	5.77e	

LSD ($P \leq 0.05$) for storage = 0.28

LSD ($P \leq 0.05$) for treatment = 0.34

LSD ($P \leq 0.05$) for storage*treatment = 0.85

Stem Bending

Mean data regarding stem bending of *Gerbera jamesonii*, is measured in degrees, with the help of a protractor, and then marked on a scale of 1 to 5 based in which angle group they fell in between 15° to 90°. The data is presented in Table 4 below. The results were significant for the stem bending of flowers for treatments and storage duration. The results were also significant for the interaction between treatments and storage duration. For treatments, the highest stem bending rating (2.8) was given to the 100 ppm Citric Acid + 40 g/L Sucrose (T8), followed by (2.7) in 40 g/L Sucrose (T4). Meanwhile, the lowest stem bending rating (1.3) was given to the 100 ppm Citric Acid + 60 g/L Sucrose treatment (T9) followed by (1.4) in 100 ppm Citric Acid treatment (T3). During storage duration, the stem bending rating increased with storage duration increasing. For storage, the highest gerbera stem bending rating (4.1) was noted on day 11, and the lowest stem bending rating (1.0) was noted on day 1. For interaction the maximum stem bending rating (5.0) was recorded on day 11 under 60g/L Sucrose treatment (T5) Moreover, the minimum stem bending rating (1.0) was recorded on day 1 under 100ppm Citric Acid + 60g/L Sucrose treatment (T9).

Therefore, our results showed that the lower the stem bending rating of a flower, the better it is at maintaining quality and freshness. Hence, our results are in agreement with. (Soad et al., 2011) who observed, that the decrease in water uptake by flowers when they were placed in water is because of vascular blockage, particularly at the base of the stem, and using chemical preservative solutions, at different concentrations acted as a biocide. This inhibited the microbial population that might have resulted in blockage of the vascular tissues, which consequently leads to stem break in cut Gerbera flowers.

Table 4: Stem bending of flowers affected by different levels of preservative solutions during storage

Treatments (Preservative solution)	Storage duration (Days)						Mean
	S1	S2	S3	S4	S5	S6	
T1	1.00	2.00	3.00	3.00	3.33	4.33	2.77a
T2	1.00	2.00	3.00	3.00	3.00	4.33	2.72a
T3	1.00	1.00	1.00	1.66	2.00	2.00	1.44b
T4	1.00	2.00	3.00	3.00	3.00	4.6	2.77a
T5	1.00	1.66	2.6	3.00	3.33	5.00	2.77a
T6	1.00	2.00	3.00	2.66	3.00	5.00	2.77a
T7	1.00	1.66	2.66	3.00	3.00	5.00	2.72a
T8	1.00	2.00	2.66	3.00	3.33	5.00	2.83a
T9	1.00	1.00	1.00	1.33	2.00	2.00	1.38b
Mean	1.00f	1.70e	2.44d	2.62c	2.88b	4.14a	

LSD ($P \leq 0.05$) for storage = 0.15

LSD ($P \leq 0.05$) for treatment = 0.19

LSD ($P \leq 0.05$) for storage*treatment = 0.47

Vase Life

The average life of gerbera cut flowers was calculated from the day the stems were transferred to the holding solutions in the lab and was assessed to be terminated when flowers lost their value of ornamental display (lost turgidity, underwent a color change, and wilted). The vase life of flowers was significantly affected by different treatments. The data recorded in Figure.1 represents the vase life of flowers in columnar form. The results show that the highest mean vase life days (11) were observed in the 100 ppm Citric Acid + 60 g/L Sucrose treatment (T9) followed by (10 days) under 100 ppm Citric Acid treatment (T3). Meanwhile, the lowest mean vase life (5.3 days) was observed in the control treatment (T1).

The higher the vase life of the flower, the better results it shows in its overall condition, as the flower maintains its quality for a longer period. Therefore, our results showed that flowers in preservative 100 ppm Citric Acid + 60 g/L Sucrose treatment (T9) and 100 ppm Citric Acid treatment (T3) maintained their freshness for the longest time among the experimental units.

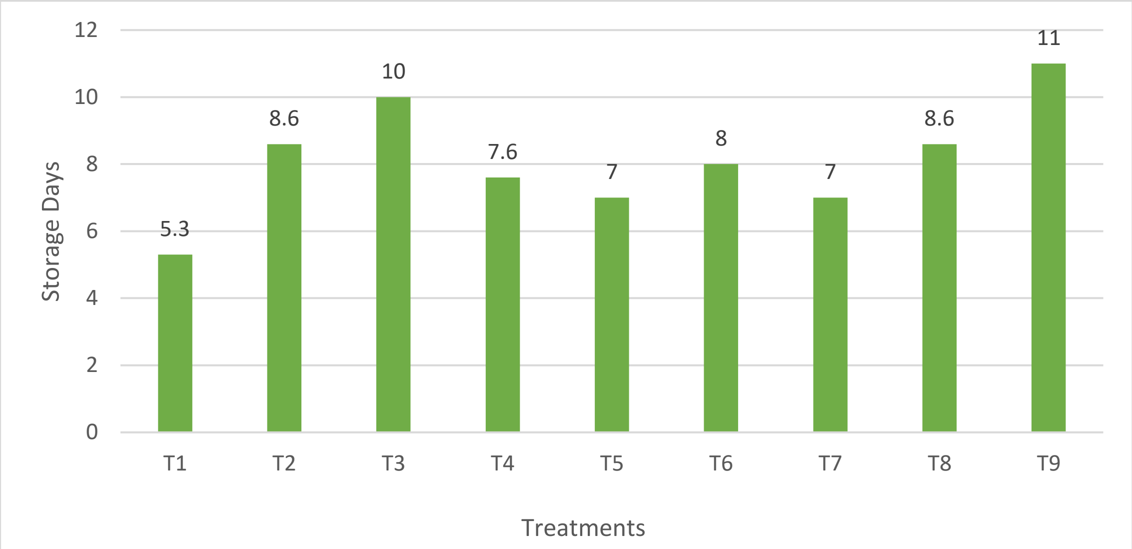

Figure 1: Vase life of *Gerbera jamesonii* flowers

CONCLUSION

It is clear from the above experiment that there is a significant difference between cut *Gerbera jamesonii* flowers that are treated with a preservative solution and the flowers that are not treated with any preservative solution. In the experiment, 100 ppm Citric Acid + 60 g/L Sucrose treatment showed the best results, followed by 100 ppm Citric Acid treatment. Flowers in control treatment showed poor quality and short vase life.

RECOMMENDATION

From the above results, it is stated that we can utilize Citric acid preservative solution in order to keep the flowers fresh for a longer period. Citric acid is an organic acid, therefore it is a less expensive and better alternative compared to other expensive artificial flower preservatives. For future studies, 100 ppm Citric Acid + 60 g/L Sucrose solution is recommended to be applied to other cut flowers.

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