Effect of different chemical preservatives on postharvest longevity of Gerbera (*Gerbera jamesonii cv. Rosalin*) cut flowers under controlled laboratory conditions

ABSTRACT

Aims: This experiment was conducted to assess the effect of different chemical preservative in vase life and quality of gerbera cut flowers.
Study design: Completely Randomized Design (CRD)
Place and Duration of Study: Department of Horticulture, Prithvi Secondary School, Nawalparsi (East), Nepal, between June 2023 and September 2023.
Methodology: Eight different preservative solutions of different concentrations (i.e. 4% sucrose, 200 ppm citric acid, 200 ppm salicylic acid and 1% $CaCl_2$) and their combinations including control treatment i.e. sole application of distilled water were replicated thrice. And, the parameters like water solution uptake, flower weight, flower diameter, stem bending and vase life was observed.
Results: The study revealed that among seven different vase solutions, the combination of 4% sucrose + 200 ppm citric acid was found superior for all the parameters observed and supposed to be the most effective vase solutions for prolonging the vase life and reducing the postharvest losses in gerbera.
Conclusion: For achieving better quality of gerbera cut flowers, they are better to be treated with sucrose in combination with citric acid or $CaCl_2$, thus can satisfactorily be recommended for commercial growers, wholesalers and retailers.

Keywords: *Vase life, cut flower, gerbera, scape bending, sucrose*

1. INTRODUCTION

"Keeping quality is an important parameter for the evaluation of cut flower and vase life is crucial in determining it's commercial value. Vase life is often used as an indicator of postharvest longevity in cut flowers, and is determined by the number of days from harvest until flower senescence, whether or not senescence is considered premature. Postharvest loss of cut flowers across all stakeholders in Nepal before reaching consumer is about 20-25% but sometimes loss of a single crop at grower's level could be as high as 30%" [1].
"Native to South Africa, Gerbera (*Gerbera jamesonii)* belongs to Asteraceae family alongside the sunflowers. They are also termed as Transvaal daisy, Barbetron daisy or Veldt daisies. These are tender perennials that are so vividly colored and have large flower heads with ray

like petals around a center disk of tiny green or black flowers. This inflorescence is supported by a long, leafless, and upright scape and the leaves are radical, lanceolate, strongly lobed, occasionally leathery, smaller at the base and broader at the top. Gerbera are positioned amongst the most popular cut flowers worldwide due to their attractive appearance, wide diversity of colors and ability to thrive under harsh environmental conditions" [2]. "It occupies fourth place among cut flowers after rose, chrysanthemum and tulips". [3].

"Gerbera has considerably short vase life as they are highly perishable owing to stem or scape bending. They are sensitive to microbial contamination at the stem end in the preservative solution, resulting into stem end blockage, imbalance between water uptake and water loss and finally wilting and shortening vase life" [4]. "Senescence of cut flowers is induced by several factors, e.g., water stress micro-organisms and ethylene effects. Stem hollowness is another reason causing lower vase life of gerbera triggered by high humidity and high temperature" [5]. "Stem bending is associated with the loss of mechanical strength due to down regulation of lignin level in flower stem" [6]. "However, the recent studies show that the calcium treatment in cut flowers enhances the mechanical strength of the inflorescence stems by increasing the lignin synthesis and accumulation" [7].

"In recent days, chemical preservatives are commercially used for extending the shelf life of flowers. Some of them are 8-hydroxyquinoline sulphate, sucrose, silver nitrate, boric acid, calcium chloride, citric acid, salicylic acid and copper sulphate etc. Floral preservatives contain carbohydrates, germicides, ethylene inhibitors, growth regulators and mineral compounds. Sugars are essential precursors for cut flower respiration. The sugar provides a respiratory substrate, while the germicides control harmful bacteria and prevent plugging of the conducting tissues. Also, they provide a nutrient supplement and assure lowering the pH which keeps the water and food conducting system in flowers working at maximum efficiency" [8].

"The longevity of cut flowers is one of the main challenges of the floriculture sector" [9]. The extension of cut flower vase life through enhanced postharvest management and care has now become commercially and economically essential. Hence, this experiment was designed to evaluate postharvest longevity in gerbera by using different chemical preservatives. Specifically, objective of this study was to assess or evaluate a combination of chemicals to be used as a vase solution which would delay neck bending and prolongs shelf life of gerbera.

2. MATERIAL AND METHODS

The study was conducted at Horticulture laboratory, Prithvi Secondary School, Nawalparasi (East) Nepal in controlled laboratory condition during June 2023. Geographically, it is located at 27.6486° latitude, 84.1330° E longitude and at an elevation of 580 MASL. The commercial Rosalin cultivar of gerbera was selected for the study. The cultivar was obtained from Abloom Flora Farm, Chitwan, Nepal. Immediately after harvesting, gerbera cut flowers were placed in fresh distilled water to retain their freshness and turgidity. The cut ends of gerbera were wrapped with moistened tissue papers inside a small plastic bags. Then they were wrapped with chart papers and placed within a CFB boxes before being transported to the laboratory for experiment. The selected fresh and healthy cut flowers were kept in different vase solutions after recutting of stem giving a slant cut at the stalk end. The experiment was laid out in completely randomized design (CRD) with eight treatments replicated thrice.

Treatment details:

Treatment 1 (T_1) – Distilled water (control)
Treatment 2 (T_2) – 4% sucrose
Treatment 3 (T_3) – 200 ppm citric acid
Treatment 4 (T_4) – 200 ppm salicylic acid

Treatment 5 (T_5) – 1% $CaCl_2$
Treatment 6 (T_6) – 4% sucrose + 200 ppm citric acid
Treatment 7 (T_7) – 4% sucrose + 200 ppm salicylic acid
Treatment 8 (T_8) – 4% sucrose + 1% $CaCl_2$

Gerbera cut flowers were placed in 500 mL conical flask containing eight types of vase solutions. Two cut flowers were placed in one flask for vase life study. The top of conical flask was wrapped with aluminum foil to prevent from evaporation loss after keeping flowers in vase solution For vase life study, flowers were kept in a controlled room having average daily temperature at 18˚C±2˚C temperature and 60±2% relative humidity.
The chemicals used in the experiment are as follows:

Sucrose: 20 gm sucrose is dissolved in 500 ml of distilled water to make 4% sucrose solution.

Calcium chloride: 5 gm of $CaCl_2$ is dissolved in 500 ml of distilled water with regular stirring to make 1% $CaCl_2$ solution.

Citric acid: 10 mg citric acid is dissolved in 500 ml distilled water with regular stirring to make 200 ppm citric acid.

Salicylic acid: Similarly, 10 mg salicylic acid is dissolved in distilled water with continuous stirring in order to obtain 200 ppm salicylic acid.

Data recording

For recording data, a random flower was selected in each treatment within each replications. The observations were taken at every one day interval i.e. at 1^{st} , 3^{rd} , 5^{th} ,7^{th} , 9^{th} and 11^{th} days. Fully opened flowers were used for recording observations. The following data were recorded: solution uptake (g), weight gain or loss (g), flower diameter, stem bending (degree) and vase life (days).

Statistical analysis

The observational data were recorded and entered into MS-Excel-7. The analysis of variance was done using R-studio. The mean was subjected to Post-Hoc analysis by DMRT (Duncan's Multiple Range Test) with 5% level of significance.

3. RESULTS AND DISCUSSION

The study revealed the wide range of variations and significant differences among the treatments for the different parameters.

Water solution uptake

According to data presented in Table 1. it is obvious that the significant effect of treatment T_6 containing 4% sucrose + 200 ppm citric acid was observed on solution uptake of gerbera flower. The treatment T_6 showed higher solution uptake (18 ml) which was significantly at par with treatment T_5 (17.50 ml). However, the lowest uptake of solution was recorded in control (8.5 ml).
Solution uptake decreased with the longevity in experimental time period. The possible cause might be due to air embolism of flower stalk at the cut end or any other microbial contamination. The studies conducted by El Sayed, [10] and Gebremedhin *et al.* [11] also supported the effect of different concentration of vase solutions on solution uptake of gerbera flowers.

Flower diameter

From the result, the maximum flower diameter (10.20 cm) was observed in vase solutions containing 4% sucrose + 200 ppm citric acid followed by T_5 and T_7 respectively. And the minimum diameter (8.12 cm) was recorded in control treatment as illustrated in Table 2. The similar result with increase in flower diameter of gerbera was reported by Krishnamoorthy, [12].

The flower diameter of gerbera gradually increase up to full opening of flower and get reduced subsequently along with the senescence. The rise in ethylene production induces rolling of petals as influenced by physical and chemical change in microsomal membrane lipids [13].

Flower weight

The weight of flower is directly correlated with the water content in stems and flowers. The significant effect of different vase solution on flower weight was observed in the study. Data in Table. 3 exhibit that the maximum flower weight (9.24 gm) at the end of shelf life was observed in treatment T_6 (4% sucrose + 200 ppm citric acid), which was significantly at par with treatments T_7 (8.65 gm) and T_8 (8.20 gm) respectively. The lowest flower weight (4.11 gm) was recorded from the control treatment as depicted in Table 3.

These results are in accordance with those of Lyang et al. [14] who indicated that the flower weight increases gradually due to the uptake of vase solutions up to full opening stage of gerbera and declines subsequently with the senescence thereafter. Sucrose influences the osmotic pressure largely thus improves the ability of cut flower to absorb water. Also, germicidal effect of vase solution has great role in reducing microbial contamination at the cut end of gerbera, facilitating better uptake of solutions.

Stem bending (degree)

From the study, the maximum degree of stem bending (43°) was observed from the control treatment with no nutrient supplement but only distilled water whereas the lowest stem deviation (18°) was recorded from treatment T_8 (4% sucrose + 1% $CaCl_2$) followed by T_5 (1% $CaCl_2$) and T_6 (4% sucrose + 200 ppm citric acid) respectively.

The results revealed that the cut gerbera flowers showed positive response with the vase solutions containing 4% sucrose and 1% $CaCl_2$ nutrient supplement. The calcium treatment in cut flowers enhances the mechanical strength of the inflorescence stems by increasing the lignification of the tissues [15].

Vase life

The longevity of gerbera cut flower shows variable results depending upon the nature of vase solutions. Data presented in Fig 1. illustrates that the treatment T_6 has longest vase life of 11 days, followed by T_8 (10.15 days) and T_7 (10 days) respectively whereas the shortest vase life was observed in control treatment (6.5 ml) with sole application of distilled water as vase solution.

These findings are in agreement with those previously obtained by Safa *et al*. [16].The reduced solution uptake of flowers, microbial contamination and ethylene synthesis induces rapid senescence in cut flowers exhibiting petal discoloration, rolling of petals and scape bending. Longevity of many cut flower is negatively influenced by the presence of ethylene by inducing various physiological responses like abscission and wilting of leaves, petals and sepals [17].

Table 1. Influence of chemical preservatives on solution uptake of gerbera cut flowers (ml)

Treatments	Water Uptake Day 3	Water uptake Day 7	Water Uptake Day 9
T1	23.5^{g}	8.33^{f}	8^{e}
T2	59.33^{ab}	12.66^{d}	10^{d}
T3	42^{c}	8.92^{e}	8.5^{e}
T4	30.66^{e}	15.33^{c}	11.33^{c}
T5	39.66^{d}	18.33^{a}	17.50^{a}
T6	**60^{a}**	**18.76^{a}**	**18^{a}**
T7	48^{b}	17.4^{b}	15^{b}
T8	26.33^{f}	12.66^{d}	11^{c}
CV	0.05	1.74	3.73
SEM	3.47	1.03	1.17
LSD	**0.59**	**0.48**	**0.81**

Means with same letter within column do not differ significantly at p= 0.05 by DMRT. *=Significant at 5% (p≤0.05), **=Significant at 1% (p≤0.01), ***=Significant at 0.1% (p≤ 0.001), NS- Non –significant, SEM- Standard error of mean, LSD- Least significant difference, CV- Coefficient of variance

Table 2. Influence of chemical preservatives on diameter of gerbera cut flowers (cm)

Treatments	Flower Diameter Day 1	Flower diameter Day 3	Flower diameter Day 5	Flower diameter Day 7	Flower diameter Day 9
T1	8^{b}	8.46^{e}	8.73^{d}	8.33^{c}	8.12^{c}
T2	8.33^{b}	9.66^{d}	9^{cd}	8.83^{bc}	8.50^{c}
T3	8.16^{b}	9.26^{ab}	9.70^{c}	8.76^{bc}	8.20^{c}
T4	8.33^{b}	9.63^{d}	9.33^{cd}	8.76^{bc}	8.50^{c}
T5	9.5^{a}	10.58^{a}	10.26^{a}	10^{a}	9.83^{a}
T6	**9.16^{a}**	**10.73^{a}**	**11.26^{a}**	**10.53^{a}**	**10.20^{a}**
T7	8.33^{b}	10.2^{c}	9.96^{bc}	9.60b	9.26^{b}
T8	8.67^{ab}	10.4^{b}	10.16^{b}	9.72ab	9.20^{b}
CV	9.76	8.96	8.8	8.09	8.29
SEM	0.19	0.24	0.42	0.24	0.2

LSD	**1.47**	**0.156**	**0.96**	**0.86**	**0.49**

Means with same letter within column do not differ significantly at p= 0.05 by DMRT. *=Significant at 5% (p≤0.05), **=Significant at 1% (p≤0.01), ***=Significant at 0.1% (p≤ 0.001), NS- Non –significant, SEM- Standard error of mean, LSD- Least significant difference, CV- Coefficient of variance

Table 3. Influence of chemical preservatives on weight of gerbera cut flowers (gm)

Treatments	Flower weight Day 1	Flower weight Day 3	Flower weight Day 5	Flower weight Day 7	Flower weight Day 9
T1	14^{d}	15.83^{e}	13.42^{d}	11.45^{de}	4.11^{e}
T2	15^{c}	16.67^{de}	14.38^{c}	11.75^{de}	6.76^{c}
T3	10.83^{e}	18.23^{bc}	12.66^{ef}	9.75^{f}	5.63^{d}
T4	14^{d}	16.67^{de}	12.27^{f}	8.11^{g}	4.52^{de}
T5	17.6^{b}	19.16^{b}	16.44^{b}	13.71^{b}	7.01^{c}
T6	**20^{a}**	**22.5^{a}**	**19.57^{a}**	**15.81^{a}**	**9.24^{a}**
T7	15.6^{c}	17.5^{cd}	13.12^{de}	12.22^{c}	8.65^{ab}
T8	14.6^{cd}	17.5^{cd}	12.27^{f}	11.36^{d}	8.20^{ab}
CV	4.01	3.62	3.32	2.22	9.48
SEM	0.91	0.72	0.86	0.7	0.65
LSD	**1.05**	**1.13**	**1.12**	**0.56**	**1.1**

Means with same letter within column do not differ significantly at p= 0.05 by DMRT. *=Significant at 5% (p≤0.05), **=Significant at 1% (p≤0.01), ***=Significant at 0.1% (p≤ 0.001), NS- Non –significant, SEM- Standard error of mean, LSD- Least significant difference, CV- Coefficient of variance

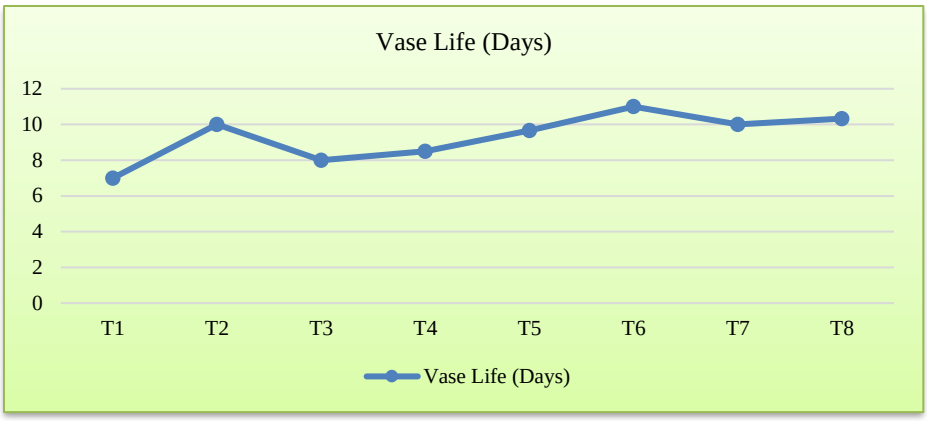

Fig. 1 Influence of chemical preservatives on vase life of gerbera cut flowers (gm)

4. CONCLUSION

The result of present experiment revealed that gerbera cut flower pulsed with 4% sucrose and 200 ppm citric acid was found significantly effective in prolonging vase life. For achieving better quality of gerbera cut flowers, they are better to be treated with sucrose in combination with citric acid or $CaCl_2$, thus can satisfactorily be recommended for commercial growers, wholesalers and retailers.

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COMPETING INTERESTS

The submitted manuscript is prepared from original research thesis and have not been published anywhere in any form or language. The results of the study are presented without manipulation and fabrication maintaining the integrity of the research study. All authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

Anil Thapa designed the experiment and performed the detail statistical analysis of the observed data. Sunita Bhandari and Gaurav Bhandari wrote and edited the manuscript along with through revision and literature review.

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