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2 **Effect of different chemical preservatives on**
3 **postharvest longevity of Gerbera (*Gerbera***
4 ***jamesonii* cv. *Rosalin*) cut flowers under**
5 **controlled laboratory conditions.**
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12 **ABSTRACT**
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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.

14
15 **Keywords:** *Vase life, cut flower, gerbera, scape bending, sucrose*
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22 **1. INTRODUCTION**
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24 Keeping quality is an important parameter for the evaluation of cut flower and vase life is
25 crucial in determining it's commercial value. Vase life is often used as an indicator of
26 postharvest longevity in cut flowers, and is determined by the number of days from harvest
27 until flower senescence, whether or not senescence is considered premature. Postharvest
28 loss of cut flowers across all stakeholders in Nepal before reaching consumer is about 20-
29 25% but sometimes loss of a single crop at grower's level could be as high as 30% [1].

30 Native to South Africa, Gerbera (*Gerbera jamesonii*) belongs to Asteraceae family alongside
31 the sunflowers. They are also termed as Transvaal daisy, Barbetron daisy or Veldt daisies.
32 These are tender perennials that are so vividly colored and have large flower heads with ray

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

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

50 In recent days, chemical preservatives are commercially used for extending the shelf life of
51 flowers. Some of them are 8-hydroxyquinoline sulphate, sucrose, silver nitrate, boric acid,
52 calcium chloride, citric acid, salicylic acid and copper sulphate etc. Floral preservatives
53 contain carbohydrates, germicides, ethylene inhibitors, growth regulators and mineral
54 compounds. Sugars are essential precursors for cut flower respiration. The sugar provides a
55 respiratory substrate, while the germicides control harmful bacteria and prevent plugging of
56 the conducting tissues. Also, they provide a nutrient supplement and assure lowering the pH
57 which keeps the water and food conducting system in flowers working at maximum efficiency
58 [8].

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

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67 **2. MATERIAL AND METHODS**

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

80

81 **Treatment details:**

82 Treatment 1 (T₁) – Distilled water (control)

83 Treatment 2 (T₂) – 4% sucrose

84 Treatment 3 (T₃) – 200 ppm citric acid

85 Treatment 4 (T₄) – 200 ppm salicylic acid

- 86 Treatment 5 (T₅) – 1% CaCl₂
87 Treatment 6 (T₆) – 4% sucrose + 200 ppm citric acid
88 Treatment 7 (T₇) – 4% sucrose + 200 ppm salicylic acid
89 Treatment 8 (T₈) – 4% sucrose + 1% CaCl₂

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91 Gerbera cut flowers were placed in 500 mL conical flask containing eight types of vase
92 solutions. Two cut flowers were placed in one flask for vase life study. The top of conical
93 flask was wrapped with aluminum foil to prevent from evaporation loss after keeping flowers
94 in vase solution For vase life study, flowers were kept in a controlled room having average
95 daily temperature at 18°C±2°C temperature and 60±2% relative humidity.

96 The chemicals used in the experiment are as follows:

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

99 **Calcium chloride:** 5 gm of CaCl₂ is dissolved in 500 ml of distilled water with regular stirring
100 to make 1% CaCl₂ solution.

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

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

105 **Data recording**

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

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112 **Statistical analysis**

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

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118 **3. RESULTS AND DISCUSSION**

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

122

123 **Water solution uptake**

124 **According to data presented in Table 1.** it is obvious that the significant effect of treatment T₆
125 containing 4% sucrose + 200 ppm citric acid was observed on solution uptake of gerbera
126 flower. The treatment T₆ showed higher solution uptake (18 ml) which was significantly at
127 par with treatment T₅ (17.50 ml). However, the lowest uptake of solution was recorded in
128 control (8.5 ml).

129 Solution uptake decreased with the longevity in experimental time period. The possible
130 cause might be due to air embolism of flower stalk at the cut end or any other microbial
131 contamination. The studies conducted **by El Sayed, [10] and Gebremedhin et al. [11]** also
132 supported the effect of different concentration of vase solutions on solution uptake of
133 gerbera flowers.

134

135 **Flower diameter**

136 From the result, the maximum flower diameter (10.20 cm) was observed in vase solutions
137 containing 4% sucrose + 200 ppm citric acid followed by T₅ and T₇ respectively. And the
138 minimum diameter (8.12 cm) was recorded in control treatment **as illustrated in Table 2**. The
139 similar result with increase in flower diameter of gerbera was reported by Krishnamoorthy,
140 [12].

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

145

146 **Flower weight**

147 The weight of flower is directly correlated with the water content in stems and flowers. The
148 significant effect of different vase solution on flower weight was observed in the study. Data
149 in Table. 3 exhibit that the maximum flower weight (9.24 gm) at the end of shelf life was
150 observed in treatment T₆ (4% sucrose + 200 ppm citric acid), which was significantly at par
151 with treatments T₇ (8.65 gm) and T₈ (8.20 gm) respectively. The lowest flower weight (4.11
152 gm) was recorded from the control treatment **as depicted in Table 3**.

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

159

160 **Stem bending (degree)**

161 From the study, the maximum degree of stem bending (43°) was observed from the control
162 treatment with no nutrient supplement but only distilled water whereas the lowest stem
163 deviation (18°) was recorded from treatment T₈ (4% sucrose + 1% CaCl₂) followed by T₅
164 (1% CaCl₂) and T₆ (4% sucrose + 200 ppm citric acid) respectively.

165 The results revealed that the cut gerbera flowers showed positive response with the vase
166 solutions containing 4% sucrose and 1% CaCl₂ nutrient supplement. The calcium treatment
167 in cut flowers enhances the mechanical strength of the inflorescence stems by increasing
168 the lignification of the tissues [15].

169

170 **Vase life**

171 The longevity of gerbera cut flower shows variable results depending upon the nature of
172 vase solutions. **Data presented in Fig 1. illustrates that** the treatment T₆ has longest vase life
173 of 11 days, followed by T₈ (10.15 days) and T₇ (10 days) respectively whereas the shortest
174 vase life was observed in control treatment (6.5 ml) with sole application of distilled water as
175 vase solution.

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

182

183 **Table 1. Influence of chemical preservatives on solution uptake of gerbera cut flowers** 184 **(ml)**

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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

186 Means with same letter within column do not differ significantly at p= 0.05 by DMRT.
187 *=Significant at 5% (p≤0.05), **=Significant at 1% (p≤0.01), ***=Significant at 0.1% (p≤
188 0.001), NS- Non –significant, SEM- Standard error of mean, LSD- Least significant
189 difference, CV- Coefficient of variance

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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}	9.60 ^b	9.26 ^b
T8	8.67 ^{ab}	10.4 ^b	10.16 ^b	9.72 ^{ab}	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
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193 Means with same letter within column do not differ significantly at p= 0.05 by DMRT.
 194 *=Significant at 5% (p≤0.05), **=Significant at 1% (p≤0.01), ***=Significant at 0.1% (p≤
 195 0.001), NS- Non –significant, SEM- Standard error of mean, LSD- Least significant
 196 difference, CV- Coefficient of variance

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

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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

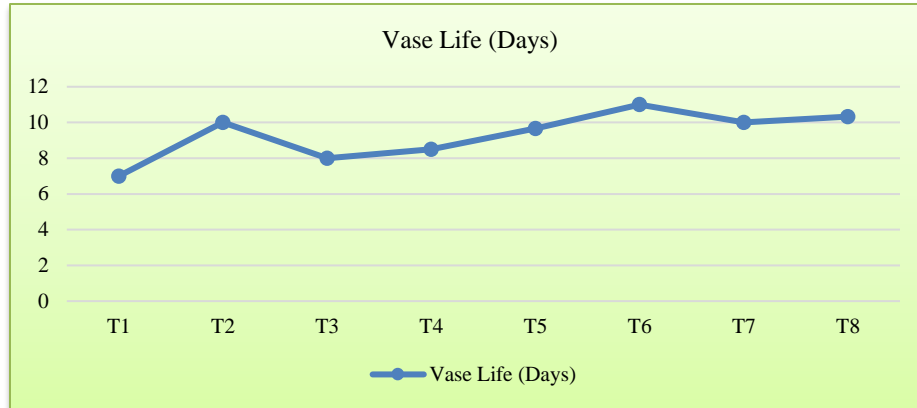
200 Means with same letter within column do not differ significantly at p= 0.05 by DMRT.
 201 *=Significant at 5% (p≤0.05), **=Significant at 1% (p≤0.01), ***=Significant at 0.1% (p≤
 202 0.001), NS- Non –significant, SEM- Standard error of mean, LSD- Least significant
 203 difference, CV- Coefficient of variance

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

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4. CONCLUSION

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214 The result of present experiment revealed that gerbera cut flower pulsed with 4% sucrose
215 and 200 ppm citric acid was found significantly effective in prolonging vase life. For
216 achieving better quality of gerbera cut flowers, they are better to be treated with sucrose in
217 combination with citric acid or CaCl₂, thus can satisfactorily be recommended for commercial
218 growers, wholesalers and retailers.

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227 study period in conducting and completing the research work.

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COMPETING INTERESTS

230

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

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AUTHORS' CONTRIBUTIONS

237

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

241

242

CONSENT

243

244 Informed consent was obtained from all the authors participated in the study. All the authors
245 declare that there is no conflict of interest with present publication. A copy of written consent
246 is available for review by the editorial board members of this journal.

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ETHICAL APPROVAL

All authors hereby declare that the experiment have been performed in accordance with the ethical standard of institution and management committee. Authors have obtained all necessary ethical approval from Institutional Management Committee.

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