Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

June 2023, Volume 36, Issue 1, Page 232-236

Postharvest longevity of cut gerbera (*Gerbera jamesonii* Bolus ex. Hook) cv. RCGH28 as affected by citric acid pulse and vase solutions

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ARTICLE INFO

Article history:
Received: 27 January, 2023
Revision: 20 March, 2023
Accepted: 02 May, 2023

Key words: *Biocide, citric acid, sucrose, pulsing, vase life, Gerbera jamesonii*

DOI: 10.56678/iahf-2023.36.01.30

ABSTRACT

The present investigation entitled "Postharvest longevity of cut gerbera (*Gerbera jamesonii* Bolus ex. Hook) cv. RCGH-28 as affected by citric acid pulse and vase solutions" was carried out at the ICAR Research Centre for NEH Region, Umiam during 2021-2022. The experiment was set up as Completely Randomised Design (CRD) including 7 (seven) treatments combinations, replicated thrice with five cuttings per replication. Uniform stems of gerbera at goose-neck stage were pulsed in 6 (six) different pulsing solutions. Pulsing treatments comprised of sucrose (3%) in combination with different levels of citric acid (100,200 and 300 mg L^{-1}). Distilled water without any chemical served as control. After pulsing, gerbera cuttings were transferred into different vases containing distilled water for assessment of their various post-harvest attributes. Effects of citric acid as biocide on pulsing solution and its impact on vase life, water relation, increase in fresh weight, petal ion leakage and other physiological parameters such as chlorophyll degradation and anthocyanin concentrations were experimented. Results indicated that pulsing of gerbera stem cuttings in 5 % Sucrose + Citric acid (300 mg L^{-1}) for 6 hours helped in improving the flower turgidity, membrane integrity and vase life as compared to control. Increased pulsing duration positively improved the post-harvest quality of gerbera.

1. Introduction

Gerbera (*Gerbera jamesonii* Bolus ex. Hook f.) belongs to Asteraceae family and occupies the fourth place in global floriculture trend in cut flowers (Sujatha *et al.*, 2002). Early floret senescence and delicacy of opened florets are the important post-harvest problems affecting the longevity of gerbera. Senescence in flower is induced by oxidative stress which caused membrane damage and collapse of petals, causing hindrance to transport and long distance marketing (Jones and McConchie, 1995). Water relation and water balance play a major role in postharvest longevity of cut flowers for reduced microbial proliferation, delayed wilting and cut flower quality enhancement. Physiological disorders such as bent neck in rose (Lu *et al.*, 2010), lack of flower opening (Bleeksma and Van Doorn, 2003) were due to disruption of water. Preservative solutions consisting sucrose, biocide and an acidifier were often used to enhance the postharvest longevity of cut flowers (Prashanth, 2006). Sucrose aids in supplying carbohydrate to the tissues and decrease the H_2O potential and thus improving the water uptake. Apart from sucrose, different biocides/ antioxidants have also been used as supplement the pulsing solutions (Solgi *et al.* 2009). Citric acid is an extensively and commercially used acidifying agent while its application has not been comprehensively studied and physiological responses of cut flowers to biocide application such as chlorophyll degradation and membrane permeability have been untapped. Therefore, in order to delay the senescence and reduce the postharvest losses in gerbera, the present work focused on the "Postharvest longevity of cut gerbera (*Gerbera jamesonii* Bolus ex. Hook) cv. RCGH28 as affected by citric acid pulse and vase solution".

2. Materials and Methods

The present investigation entitled "Postharvest longevity of cut gerbera (*Gerbera jamesonii* Bolus ex. Hook) cv. RCGH-

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28 as affected by citric acid pulse and vase solutions" was carried out at the ICAR Research Centre for NEH Region, Umiam during 2021-2022. Cut gerbera flowers were kept in a laboratory with a maximum and minimum temperature of 24±2 and 20±2ºC respectively and relative humidity (RH) of 54±5%. The experiment consisted of seven treatments *viz.*, T_1 Control (distilled water); T_2 *viz.*, 3% Sucrose + Citric acid (100 mg L^{-1}) + 3 hours Pulsing; T_3 *viz.*, 4% Sucrose + Citric acid (200 mg L^{-1}) + 3 hours Pulsing; T_4 *viz.*, 5% Sucrose + Citric acid (300 mg L^{-1}) + 3 hours Pulsing; T_5 *viz.*, 3% Sucrose + Citric acid (100 mg L^{-1}) + 6 hours Pulsing; T_6 *viz.*, 4 % Sucrose + Citric acid (200 mg L^{-1}) + 6 hours Pulsing and T_7 *viz.*, 5 % Sucrose + Citric acid (300 mg L^{-1}) + 6 hours Pulsing). Cut stems were put in distilled water after their respective pulsing treatments. The experiment was set up as Completely Randomised Design including seven (seven) treatments combinations, replicated thrice with five cuttings per replication and observations were recorded as stated below:

Vase life (days)

Vase life was measured in days at the time of keeping the flowers in vase until the flowers show any of the following symptoms: stem bending or neck bending or 50% petal discolouration or wilting.

Amount of vase solution uptake (ml/stem)

Amount of vase solution uptake was calculated by using the following formula.

Amount of pulsing solution uptake (ml) = Initial volume of solution (ml) – Final volume of the solution (ml)

Per cent weight increase of cut stems (%)

Increase in weight of cut stems was worked out by recording the initial and final weight of stems at the time of pulsing them in preservative solutions.

Per cent weight increase of cut stems after pulsing= $(W_2-W_{1)}/W_1 \times 100$

W_1- Weight of cut stems before pulsing

W_2- Weight of cut stems after pulsing

Determination of ion leakage percentage (%)

Ion leakage percentage for estimation of membrane permeability was measured using an electrical conductivity meter based on Pooviah (1973) method. Petal samples were cut into 1 cm segments and placed in individual stoppered vials containing 25 ml of deionized water after two washes with distilled water to remove surface contamination. These samples were incubated at room temperature (25°C) on a shaker (150 rpm) for 30 min. Electrical conductivity of solution (EC_1) was read after shaking. Samples were then placed in thermostatic water bath at 95°C for 15 min and the second reading (EC_2) was determined after cooling the solutions to room temperature. Ion leakage percentage was calculated as EC_1/EC_2 and expressed as percent.

Photosynthetic capacity (mg g^{-1}FW)

To measure the photosynthetic pigments (Chlorophyll a and Chlorophyll b), fully expanded mature leaves were sampled and dissolved in acetone (80%) and being centrifuged, the absorbance of each sample was measured using a spectrophotometer (Perkin Elmer, Lambda 25, UV/VIS Spectrophotometer) in wavelengths of 663.2, 646.8 and 470 nm. The amount of pigments were calculated based on (Lichtenthaler and Wellburn, 1983).

Chl a= $(12.25 \times A_{663.2}) - (2.79 \times A_{646.8})$

Chl b= $(21.21 \times A_{646.8}) - (5.1 \times A_{663.2})$

Determination of anthocyanin concentrations (mg g^{-1}FW)

The third floret from the bottom of each spike was excised 4 days after harvest and the petals (200 mg) were diced, the pieces were immersed in 5 ml of 1% HCl in methanol in the dark at 4 ºC for overnight. Supernatants were then decanted and washed twice with 2.5 ml of acidified methanol. All supernatants were combined to 10 ml and the absorbance of the combined solution was measured by spectrophotometer at 530 nm (Ichimura and Hiraya, 1999).

Statistics

Treatment means were compared by Duncan's Multiple Range Test (DMRT) at 0.05 probability level. All statistical analysis was done By SAS version 9.2 (SAS Institute, 2010).

3. Results and Discussion

Effect of pulsing solution on Per cent weight increase of cut stems (%)

With respect to pulsing solution effect on percent weight increase of cut stems**,** data presented in Table 1 show that highest percent weight increase (16.85±1.45 %, 14.05±2.21 % and 13.68±0.88 %) was recorded in stems placed in T7 *viz.*, 5% Sucrose + Citric acid (300 mg L^{-1}) + 6 hours followed by T6 *viz.*, 4% Sucrose + Citric acid (200 mg L^{-1}) + 6 hours Pulsing and T5 *viz.*, 3% Sucrose + Citric acid (100 mg L^{-1}) respectively against control (distilled water). However, the lowest values (8.22±1.89 %, 9.12±1.09 % and 12.86±1.75 %) for the parameter was recorded in T1 (Control) followed by T2 *viz.*, 3% Sucrose + Citric acid (300 mg L^{-1}) + 3 hours pulsing and T3 (4% Sucrose + Citric acid (200 mg L^{-1}) + 3 hours Pulsing respectively. Knee (2000) had reported that with the increased in the citric acid concentration, there was corresponding increased on fresh weight of cut flowers. This is in accordance with cut flower preserving solution recommendations; stating that with decrement of vase solution pH (acidifying), there is controlled microbial proliferation (Nowak and Rudnicki, 1990). Sucrose might also has beneficial effect on maintaining higher fresh weights in cut flowering stems by inducing stomatal closure in the leaves and thus, reducing water loss (Marousky, 1972). The reduction in increased percent weight of cut stem without pulsing treatment in T1

might be due to decreased water uptake and increased water loss. The above results are also corroborated with the findings of Jain *et al.* (2017) in gladiolus and Vaidamitra (2017) in gerbera.

Effect of pulsing solution on vase solution uptake of gerbera (ml)

Data recorded in Table 1 indicated that 5% Sucrose + Citric acid (300 mg L^{-1}) + 6 hours Pulsing was most effective in maintaining water uptake against control treatment (distilled water). The absorption of vase solution was maximum (6.74±0.06 ml) in the T7 *viz.*, 5% Sucrose + Citric acid (300 mg L^{-1}) + 6 hours Pulsing followed by T3 (5.92±0.06ml) and T4 (5.68±0.06 ml) which were statistically at par against the lowest value for T1 (2.97±0.53 ml). This suggests that the synergistic effect of sucrose and citric acid on increased vase solution uptake was due to suppression of microbial growth. Citric acid might inhibit stem plugging by reducing the pH of the solution and acts as a germicide which decreases the microbial growth in vascular bundles resulting in better water balance. Similar findings were reported by Helaly (2019) in gerbera, and Lakmali *et al.* (2016) in alstroemera.

Effect of pulsing solution on vase life of gerbera

There was no marked effect on the vase life of cut gerberas with the different pulsing treatment used. However, vase life of gerbera ranges from 4.96±0.64 days in T1 (control) *viz.*, distilled water to 6.50±0.25 days in T7 *viz.*, 5% Sucrose + Citric acid (300 mg L^{-1}) + 6 hours Pulsing. Among the different pulsing solution, the maximum vase life (6.50±0.25 days) was recorded from the flowers pulsed with T7 followed by T4 (6.46 ± 0.27 days), T2 (6.32± 0.50 days), T5 (5.91±0.01 days), T3 (5.77 ± 0.23 days) and T6 (5.59 ± 0.31 days) with minimum days in control treatment (4.96±0.64 days). Citric acid act as acidifier which inhibits the growth of microorganisms (Dole and Wilkins, 1999). The result is corroborated with the findings of De *et al.* (1996) in gerbera. Vase solution uptake has a close association with vase life of gerbera cut flowers (Table 1). Maximum vase solution uptake in T7 also recorded the longest vase life whilst T1 with minimum vase solution uptake recorded the shortest vase life These results are in agreement with Meeteren (1987).

Effect of pulsing solution on Petal Ion Leakage (%)

Results (Table 1) showed that the petal ion leakage of gerbera cut flowers was significantly affected as a result of using different pulsing treatments. Among the different pulsing solution, the maximum petal ion leakage (47.01±1.16 %) was recorded from the flowers pulsed with T1 (control) followed by T6 (44.87 ± 3.05 %), T3 (40.56± 4.05 %), T5 (35.81±1.86 days), T4 (34.06 ± 1.84%), with minimum ion leakage in T7 (20.05±2.83%).

Results (Table 1) showed that the petal ion leakage of gerbera cut flowers was significantly affected as a result of using different pulsing treatments. Among the different pulsing solution, the maximum petal ion leakage (47.01±1.16 %) was recorded from the flowers pulsed with T1 (control) followed by T6 (44.87 ± 3.05 %), T3 (40.56± 4.05 %), T5 (35.81±1.86 days), T4 (34.06 ± 1.84%), with minimum ion leakage in T7 (20.05±2.83%).

Changes in membrane permeability are relative of changes in the rate of ion leakage from tissue samples (Bir and Bramlage, 1973). T7 and T4 has longer vase life (6.50±0.25 and 6.46±0.27 days respectively) with 20.05±2.83 and 34.06±1.86 % ion leakage, respectively; while T1 and T6 with shorter vase life (4.96±0.64 and 5.59±0.31 days respectively) showed higher ion leakage (47.01±1.16 and 44.87±3.05 % respectively). With increased pulsing concentration and duration, there was delayed ion leakage. Joshi (2012) reported that sucrose helps in increasing the level of moisture retention, increase osmotic potential of cytoplasm and reduction of transpiration losses.

Effect of pulsing solution on photosynthetic capacity (mg g^{-1} FW)

Data recorded in Table 1 indicate that treatment with T7 (5 % Sucrose + Citric acid (300 mg L^{-1}) + 6 hours Pulsing was most effective in delaying chlorophyll degradation compared to T1 (control). Chlorophyll a concentration was higher than chlorophyll b for all the treatments. When gerbera cut flowers were given treatment T7 *viz.*, 5% Sucrose + Citric acid (300 mg L^{-1}) with 6 hours Pulsing, chlorophyll content was 0.840±0.03 and 0.507±0.42 mg g^{-1} FW for chlorophyll a and chlorophyll b respectively. Relatively higher chlorophyll concentration was recorded in treatment T6 *viz.*, 4% Sucrose + Citric acid (200 mg L^{-1}) with 6 hours Pulsing with 0.766±0.34 and 0.477±0.16 mg g^{-1} FW for chlorophyll a and chlorophyll b respectively. Control treatment *viz.*, T1 (distilled water), gave the lowest value (0.311±0.07 and 0.133±0.06 mg g^{-1} FW) for chlorophyll a and chlorophyll b respectively. Increased sucrose concentration and pulsing duration reduced chlorophyll content degradation and preserved carbohydrates content and carbohydrate availability might play a role in synthesis of photosynthetic pigments. Ichimura and Korenaga (1998) also reported that addition of sucrose promotes pigmentation of petal colors in Eustoma. Sucrose might also affect the nutrition/energy supply of the flowers since they act as a source of nutrition for tissues approaching carbohydrate starvation (Halevy and Mayak, 1981).

Effect of pulsing solution on Anthocyanin concentrations (mg g^{-1} FW)

There is significant affect in anthocyanin concentration with different pulsing treatments among the cut gerberas. Concentrations of anthocyanin in cut gerberas increased with increased citric acid concentration and pulsing duration. Anthocyanin concentration was highest in T7 (1.81±0.25 mgg^{-1}FW) followed by T6 (1.72±0.06 mgg^{-1}FW) and T5 (1.39±0.03 mgg^{-1}FW). The lowest anthocyanin concentration was found in gerbera cut flowers with treatment T1 *viz*., (0.08 ±0.07 mgg^{-1}FW) followed by T2 (1.04±0.19 mgg^{-1}fw) and T3 (1.19 ±0.04 mgg^{-1}FW). The above findings corroborated with the findings of Ichimura and Korenaga (1998) in Eustoma who reported on the positive correlation between sucrose content and pigmentation of petal colors. Water uptake of cut flowers decreases with time and higher sucrose level might leads to more absorbance of sucrose. Varying level of sucrose concentration taken up by spikes might be the reason for the corresponding differences in the anthocyanin concentration. This is in agreement with the findings obtained on sweet pea (Ichimura and Hiraya, 1999).

4. Summary

From the analysis of variance, the effects citric acid pulse and vase solutions on postharvest longevity of cut gerbera was found to be statistically significant. Results indicated that pulsing of gerbera stem cuttings in 5 % Sucrose + Citric acid (300 mg L^{-1}) for 6 hours helped in improving the flower turgidity, membrane integrity and vase life as compared to control. Increased pulsing duration positively improved the post-harvest quality of gerbera.

5. Acknowledgement

The authors acknowledged the facilities provided by the Director, ICAR Research Centre for North East Region, Umiam.

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Table 1. Effect of the different Pulsing solutions on vase life (days), vase solution uptake (ml/stem), per cent weight increase of cut stems (%), ion leakage percentage (%), photosynthetic capacity (mg g^{-1}FW) and anthocyanin concentrations (mg g^{-1}FW) of gerbera cut flowers.

S/No.	Treatments	Vase life (days)	Vase solution uptake (ml/stem)	Per cent weight increase of cut stems (%)	Ion leakage percentage (%)	Chlorophyll a (mg g^{-1}FW)	Chlorophyll b (mg g^{-}FW)	Anthocyanin content (mg g^{-1}FW)
1	T1	4.96±0.64a	2.97±0.53^{c}	8.22±1.89^{b}	47.01±1.16^{bc}	0.311±0.07^{d}	0.133±0.06^{c}	0.88±0.07^{c}
2	T2	6.32±0.50^{a}	3.87±0.03^{bc}	9.12±1.09^{b}	20.56±2.42^{c}	0.354±0.05^{cd}	0.236±0.10^{b}	1.04±0.19^{abc}
3	T3	5.77±0.23^{a}	5.92±0.06^{ab}	12.86±1.75^{ab}	40.56±4.05^{ab}	0.439±0.10^{bc}	0.266±0.07^{b}	1.19±0.04^{bc}
4	T4	6.46±0.27^{a}	5.68±0.06^{ab}	13.39±1.45^{ab}	34.06±1.84^{ab}	0.404±0.22^{bc}	0.233±0.24^{b}	0.78±0.14^{c}
5	T5	5.91±0.01^{a}	4.93±0.27^{abc}	13.68±0.88^{ab}	35.81±1.86^{ab}	0.483±0.71^{b}	0.312±0.15^{b}	1.39±0.03^{abc}
6	T6	5.59±0.31^{a}	4.86±0.05^{abc}	14.05±2.21^{ab}	44.87±3.05^{ab}	0.766±0.34^{a}	0.477±0.16^{a}	1.72±0.06^{a}
7	T7	6.50±0.25^{a}	6.74±0.06^{a}	16.85±1.45^{a}	20.05±2.83^{a}	0.840±0.03^{a}	0.507±0.42^{a}	1.81±0.25^{ab}
	LSD (0.05)	-	0.61	5.21	7.68	0.01	0/05	0.49

Notes : Values within a column followed by different letters indicate significant differences among treatments of different concentrations of sucrose and citric acid at $P \leq 0.01$ (Duncan's multiple range test) ; Each value represents the mean of three replicates ± SE (m).