



Influence of pulse chemical treatments on water relation in cut gerbera (*Gerbera jamesonii* cv. Pags) flowers

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Abstract

The effect of 24 h pulse chemical treatments on the vase life and quality of cut gerbera (*Gerbera jamesonii* cv. Pags) flowers was studied in a completed randomized experiment. Cut flowers were kept in vases containing solutions of 8-hydroxyquinoline sulfate (8-HQS), aluminium sulfate, citric acid, calcium chloride, silver nitrate and distilled water (control). Thirty mg l⁻¹ of sucrose was used for all treatments. Vase life was significantly ($P < 0.05$) extended from 12.0 days (control) to 24.5 days by using combination of aluminium sulfate at 300 ppm and sucrose. Fresh weight (FW) and relative water content (RWC) data indicated that chemical treatments acted primarily by improving water uptake and consequently extending vase life, which suggests that the vase life, scape bending and wilting are all related to the water status of flower. The curvature of the stem in the end of vase life was associated with the folding and wilting of the stem in the vase.

Key words: Cut flowers, floral food, postharvest, turgidity, water uptake, wilting.

Introduction

Gerbera jamesonii is one of the most important cut flowers in the world, but is highly perishable. Many studies have indicated the importance of improving postharvest techniques of gerbera flower leading to delay its senescence and to extend its vase life ^{1-5, 21}. The prevalent method for maintaining the vase life of cut flowers is the use of chemical treatments which offered potential advantages of extending the vase life and maintaining flower quality ⁶⁻⁸. Some investigations have been conducted by adding various chemical treatments to the vase water resulting in cut flowers senescence being delayed considerably ^{1, 9}. Some others reported the vase life of cut eustoma flowers are greatly improved by sugar and aluminium sulfate ^{7, 8}. Application of CaCl₂ extended the vase life of flowers and reduced flowers bending of gerbera ¹⁰. Application of 8-HQS reduced vascular blockages in rose, freesia and carnation cut flowers ^{11, 12}. Furthermore, sucrose alone has not been usually used, because sugar treatment without germicides promotes bacterial proliferation, leading to shortening of the vase life. For flower conservation, large amount of soluble carbohydrates is required as the substrate for respiration and synthetic materials as well as osmolytes. Some vase solutions including sucrose extend the vase life of cut flowers ¹³⁻¹⁵.

The perishability of gerbera appears to be principally result of a rapid decline in water uptake and even more rapid water loss leading to desiccation. It was hypothesized that if cut gerbera (*Gerbera jamesonii* cv. Pags) flowers are treated by pulse chemical treatments, vascular blockage is inhibited or water retention in flowers increases, thus, the vase life and quality of cut gerbera flowers are improved.

Material and Methods

Cut gerbera (*Gerbera jamesonii* L. cv. Pags) flowers were pulse-treated for 24 h in the Postharvest Lab, in spring 2007. The pulse treatments of 300 ml vase solution with 30 mg l⁻¹ sucrose were: a) 8-hydroxyquinoline sulfate (8-HQS) (Sigma Chemical Co.) at 200, 400 and 600 ppm as T₁, T₂ and T₃; b) aluminium sulfate (Al₂(SO₄)₃·7H₂O) at 200, 300 and 400 ppm as T₄, T₅ and T₆; c) citric acid [C₆H₅O₇-(OOH)₃] at 200, 300 and 400 ppm as T₇, T₈ and T₉; d) calcium chloride [CaCl₂·2 H₂O] at 100, 200 and 300 ppm as T₁₀, T₁₁ and T₁₂; e) silver nitrate (AgNO₃·2 H₂O) at 50, 100 and 150 ppm as T₁₃, T₁₄ and T₁₅ and f) distilled water (control) as T₀. The final pH of each solution was measured at the end of 24 h pulsing. Ten replicates were used in a completely randomized design (CRD), and flower samples were collected from the five replicates. The entire experiment was repeated twice. After the pulse treatment, all the flowers were placed in 400 ml of distilled water in glass tubes sealed with parafilm to prevent water evaporation. All tubes were maintained at 20±1°C temperature and 60±5% relative humidity under a 12 h photoperiod with 20 µmol m⁻² s⁻¹ irradiance with cool-white fluorescent light.

Vase life was recorded as the time period when more than one third of the outer petals of inflorescence start to be brown/wilted. Fresh weight of five individual selected flowers was recorded daily and percentage increase or decrease in fresh weight compared to that on Day 0 as initial fresh weight (IFW%) over 12 days. Cumulative uptake of vase water was estimated by measuring the vase water remaining after every 24 h, and total loss in vase water was expressed as ml g FW⁻¹ d⁻¹. Relative water content (RWC) as a mean of cut flowers water status was calculated as $RWC = [(FW-DW)/(TW-DW)] \times 100$, where FW, DW and TW are fresh weight,

dry weight and turgid weight. Inflorescence diameter (mm) at the end of vase life was compared to that on Day 0. Scape curvature was measured daily using a protractor and expressed with respect to the angle on Day 0 of vase life. When more than one third of the outer petals of gerbera inflorescence started to be brown/wilted was the end of vase life and percentage wilting was measured $[(\text{flowers of } <30\% \text{ wilting} / \text{total flowers}) \times 100]^1$. Data were subjected to analysis of variance and Duncan's multiple range test at the ($P < 0.05$).

Results

The 24 h pulse treatments significant at $P < 0.05$ extended the vase life of cut gerbera (*Gerbera jamesonii* L. cv. Pags) from 12 days with control (T_0) to 24.5 days by using combination of aluminium sulfate (300 ppm) (T_5); 22.5 days with citric acid (400 ppm) (T_8) and 21.3 days with calcium chloride (100 ppm) (T_9) (Table 1). Fresh weight increased initially and then decreased after one week (Fig. 1). The changes (decreases or increases) in fresh weights (as percentage of initial fresh weight) and changes in RWC were related to total water uptake (Table 1). The greatest amounts of fresh weights (96.4 and 89.0% IFW) and RWC (54.7 and 53.2%), on 12th day were recorded in T_5 and T_8 treatments, respectively. The lowest amounts of fresh weights (70.2 and 72.2% IFW) were recorded in T_0 and T_{10} treatments, respectively (Table 1). The rate of water uptake varied significantly ($P < 0.05$) in each treatment. It decreased with age in all treatments, but the least decrease occurred in the flowers in T_5 and T_8 treatments compared with other treatments (Fig. 2).

The largest (76.28 mm) and the smallest flower diameter (59.11 mm) at the end of vase life were in T_5 and T_1 treatments, respectively (Table 1). Scape curvature increased with age, the greatest amount on 10th day being in control (T_0). About 38% of the flowers wilted in T_0 treatment, whereas only 2.0% in T_5 (Table 2). Relative water

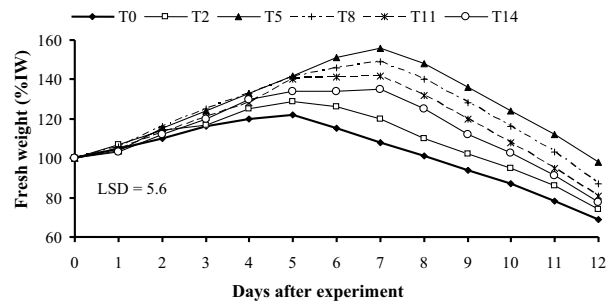


Figure 1. Effect of 24-h pulsing chemical treatment on fresh weight of gerbera (*G. jamesonii* cv. Pags). T_0 control (distilled water); T_2 8-HQS (at 400 ppm); T_5 aluminium sulfate (at 300 ppm); T_8 citric acid (at 300 ppm); T_{11} as calcium chloride (at 200 ppm); T_{14} silver nitrate (at 100 ppm). FW was as percent of initial FW (%IW). Each value is average of five replications and LSD was calculated at $P = 0.05$.

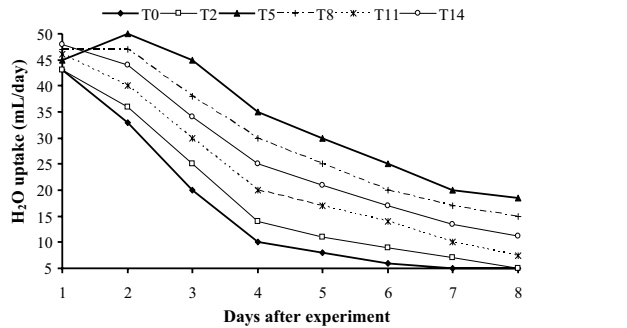


Figure 2. Effect of 24-h pulsing chemical treatment on H_2O uptake by gerbera (*G. jamesonii* cv. Pags) during the first 8 days of experiment. T_0 control (distilled water); T_2 8-HQS (at 400 ppm); T_5 aluminium sulfate (at 300 ppm); T_8 citric acid (at 300 ppm); T_{11} calcium chloride (at 200 ppm); T_{14} silver nitrate (at 100 ppm). * Each value is average of five replications and LSD was calculated at $P = 0.05$.

Table 1. Effect of 24-h pulsing with germicides on flower diameter (mm), H_2O uptake ($ml\ g\ FW^{-1}$), fresh weight (%IW) and vase life (day) of gerbera (*G. jamesonii* cv. Pags).*

Treatment	ppm		Final ¹ pH	Diameter ² (mm)	H_2O uptake ³ ($ml\ g\ FW^{-1}$)	FW ⁴ (%IFW)	Vase life ⁵ (day)
Control		T_0	6.9	62.92	130	70.2	11.5
8-HQS	200	T_1	5.3	59.11	153	80.5	13.3
	400	T_2	4.8	57.18	150	74.6	12.7
	600	T_3	4.6	67.23	158	81.9	14.6
$Al_2(SO_4)_3$	200	T_4	4.9	75.35	187	85.7	18.5
	300	T_5	4.5	76.28	230	96.4	24.5
	400	T_6	4.4	65.73	194	85.2	19.7
$C_6H_5O_7-(OOH)_3$	200	T_7	5.2	64.29	185	84.6	18.7
	300	T_8	4.9	67.38	210	89.0	22.5
	400	T_9	4.7	57.82	227	86.1	21.3
$CaCl_2$	100	T_{10}	5.9	57.04	170	72.2	15.7
	200	T_{11}	5.6	61.51	180	80.2	17.3
	300	T_{12}	5.7	67.18	194	74.3	17.3
$AgNO_3$	50	T_{13}	5.5	57.68	182	73.6	17.8
	100	T_{14}	5.2	62.97	201	77.5	18.3
	150	T_{15}	5.2	74.57	157	74.8	15
LSD			0.5	3.58	21	8.5	2.8

*Each value is average of five replications and LSD was calculated at $*P < 0.05$. ¹ The pH was measured at the end of 24 h pulsing. ² Maximum diameter of flower at the end of vase life; ³ total water uptake during 12 days ($ml\ g\ FW^{-1}$); ⁴ FW was as percent of initial FW (%IW); ⁵ when more than one third of the outer petals of gerbera inflorescence start to be brown/wilted was the end of vase life.

Table 2. Effect of 24-h pulsing with germicides on wilting, scape curvature and relative water content of gerbera (*G. jamesonii* cv. Pags) on the 10th day of vase life.*

Treatment	ppm		Wilted ¹ (%)	Scape ² curvature ^o	RWC ³ (%)	Vase life (day)
Control		T ₀	90	38.5	37.8	11.5
8-HQS	200	T ₁	70	28.0	45.7	13.3
	400	T ₂	75	23.4	49.8	12.7
	600	T ₃	15	20.0	51.7	14.6
Al ₂ (SO ₄) ₃	200	T ₄	0	5.0	51.8	18.5
	300	T ₅	20	2.0	54.7	24.5
	400	T ₆	20	34.0	42.3	19.7
C ₆ H ₅ O ₇ -(OOH) ₃	200	T ₇	0	19.5	46.0	18.7
	300	T ₈	30	6.0	53.2	22.5
	400	T ₉	5	17.5	52.8	21.3
CaCl ₂	100	T ₁₀	55	15.5	42.1	15.7
	200	T ₁₁	45	32.5	19.3	17.3
	300	T ₁₂	45	17.5	54.5	17.3
AgNO ₃	50	T ₁₃	10	10.5	45.4	17.8
	100	T ₁₄	5	11.0	49.5	18.3
	150	T ₁₅	5	12.6	44.4	15
LSD			13	5.7	19.3	2.8

*Each value is average of five replications and LSD was calculated at (*P<0.05). ¹When the ligulae of an inflorescence on an upright stem have visibly lost their turgidity [flowers of <20% wilted/(total flowers) x 100]. ²Bending refers to a degree of curvature ≥ 30° in 40% of scapes. ³RWC was calculated as [(FW-DW)/(TW-DW)] x 100.

content and water uptake correlated positively with vase life of the cut gerbera and flower wilting negatively with the vase life, but correlation of vase life with diameter of the flowers was insignificant (Fig. 3).

Discussion

The results indicated that many aspects of postharvest quality (vase life, RWC, scape bending and wilting) of cut gerbera (cv. Pags) flowers were significantly (P<0.05) influenced by the combination of sucrose and the type of chemical treatments like aluminium sulfate, citric acid, 8-HQS, calcium chloride and silver nitrate at different concentrations. It can be explained that application of these chemical preservatives probably reduced microbial contamination in flower stems or vase water and consequently improved water conductance by preventing bacterial growth and reducing occlusions ¹. It is clear that combination of aluminium sulfate and sucrose was more effective on inhibition of vascular blockage and increasing in water retention of cut gerbera flowers than the other treatments. The beneficial effects of vase water by application of aluminium sulfate have long been recognized as a flower food ^{1,7,11}. It can be inferred that the postharvest quality is related to water loss from cut gerbera flowers or differences in ability of stems to take up water. Variations in water uptake (Fig. 2) resulted in fresh weight changes (Fig. 1), for example, the higher water uptake in T₅ and T₈ treatments and the greater increases in the fresh weight and RWC (Table 1). Wilting of gerbera flowers occurred after water uptake and leaf moisture content declined. It was found that vase life of cut flowers was above all dependent on the water balance, which is the relation between the capacity of the flower for water uptake, water transport and transpiration ¹⁶. Maintenance of an optimal water status was the most important factor in cut flower vase life but the underlying mechanism(s) leading to disturbed water balance were still unresolved ¹⁷. Water uptake declined with time for all treatments, but the rate of decline varied between treatments. Accordingly, there were significant differences in the initial fresh weight (%). It can be said the most common symptoms

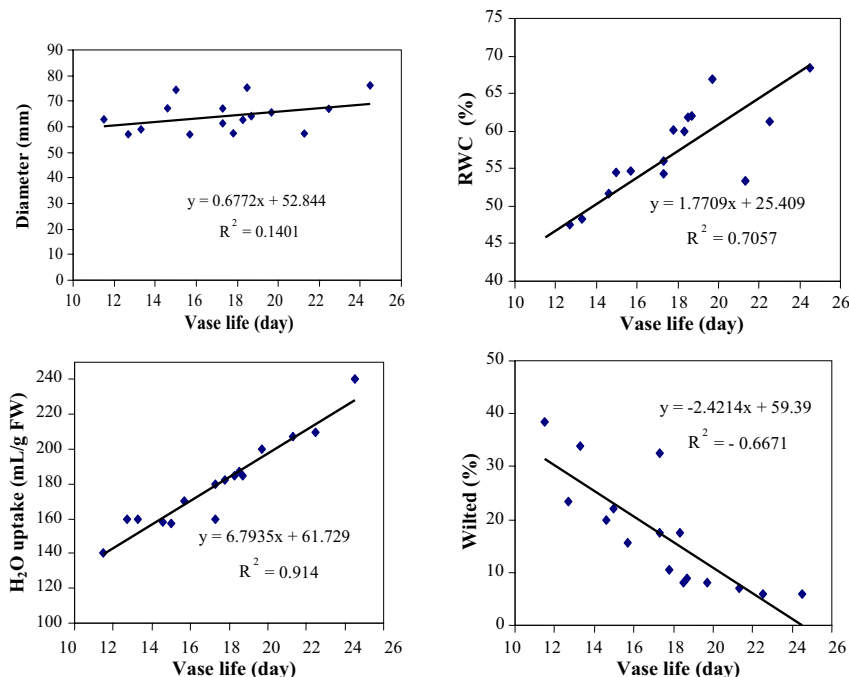


Figure 3. Simple regression lines between the response variable (vase life) with other variables (diameter, RWC, H₂O uptake, wilting) of cut gerbera (*G. jamesonii* cv. Pags) flowers.

of imbalance in the water status are wilting, folding and scape bending¹⁸. In addition, it can be said the vase life could be improved by using sucrose (30 g l⁻¹), because sugar status of flower has an important role in the postharvest quality. Sugars contribute to the osmotic potential of tissues and maintain the respiration rate and membrane integrity^{19,20}. That is why sugars can be used in combination with chemical preservative solutions to extend the vase life of flowers.

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