Effects of some preservative solutions on the vase life of cut rose flowers

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Abstract

The vase life of cut rose flowers is generally short due to bent neck and wilting. This study was conducted to determine the effects of different concentrations of citric acid (CA) (100, 200, and 300 mg L^{-1}), salicylic acid (SA) (100, 200, and 300 mg L^{-1}), succinic acid (SUA) (100, 300, and 500 mg L^{-1}), glycolic acid (GA) (76, 152, and 228 mg L^{-1}), and benzethonium chloride (BC) (25, 50, and 100 mg L^{-1}) on the vase life, relative fresh weight, and water uptake of *Rosa hybrida* 'Samourai'. Distilled water was used as the control. The results showed that the vase solutions containing 100 mg L^{-1} of CA (13.27 days), 100 mg L^{-1} of SUA (13.07 days), and 25 mg L^{-1} of BC (13.0 days) significantly increased vase life as compared with the control (8.53 days).

Keywords: glycolic acid, succinic acid, citric acid, salicylic acid, benzethonium chloride

INTRODUCTION

Vase life is one of the important quality parameters in cut flowers and refers to the duration from the placement of flower stems into the vase solution to the loss of the visible ornamental value (Halevy and Mayak, 1981). The vase life of cut rose flowers is generally short due to bent neck and wilting (Halevy and Mayak, 1979; Van Doorn and Perik, 1990; Ichimura et al., 1999). The development of such symptoms is considered to be caused by vascular occlusion and occlusion inhibits water supply to the flowers (Van Doorn, 1997; Ichimura et al., 1999). Vascular occlusion is caused by different factors such as bacteria (Van Doorn et al., 1989), air embolism (Van Doorn, 1990), and the physiological responses of stems to cutting (Ichimura et al., 1999). Van Doorn et al. (1989) reported that there was a positive correlation between the number of bacteria and the water conductivity of the stem in cut roses and that occlusion was indeed caused by bacteria. The rapid proliferation of microorganisms in vase water results in xylem blockage, water stress, and the subsequent reduction in cut flower longevity (Van Doorn and Perik, 1990). Numerous compounds were used to prevent this problem. Some of these compounds slow down physiological processes and delay senescence, whereas the others reduce transpiration, diminish bacterial growth, and enhance water uptake (Särkkä, 2005).

Numerous studies conducted on cut roses demonstrated the positive effects of various chemical preservatives on the postharvest water relations and vase life of cut roses. Although the positive effects of salicylic acid (Alaey et al., 2011) and citric acid out of these compounds on the vase life of cut roses have been revealed, research on succinic acid, glycolic acid and benzethonium chloride is limited. Therefore, the effects of succinic acid, glycolic acid, benzethonium chloride, salicylic acid and citric acid on the vase life of cut rose flowers were investigated in this study.

MATERIALS AND METHODS

Cut rose (*Rosa hybrida* 'Samourai') flowers were grown under standard hydroponic greenhouse conditions in Şanlıurfa, Turkey in 2017. The flowers were harvested at the commercial harvest stage (when the petals were about to reflex), immediately placed in tap water, and then transported to the postharvest laboratory at the Department of Horticulture in the Faculty of Agriculture at Ankara University in Ankara, Turkey, within 6 h by airplane.

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At the laboratory, the stems were re-cut to a length of 40 cm and only the three upper leaves were retained on each stem. The flowers were placed into 1000 mL glass vases containing 750 mL of vase solution, with each vase containing 5 flowers. Each vase solution contained distilled water (control), citric acid (CA) (100, 200, and 300 mg L^{-1}) (Carlo Erba Reagents, Cas no: 5949-291-1), salicylic acid (SA) (100, 200, and 300 mg L^{-1}) (Merck, Cas no: 69-72-7), succinic acid (SUA) (100, 300, and 500 mg L^{-1}) (Merck, Cas no: 110-15-6), glycolic acid (GA) (76, 152, and 228 mg L^{-1}) (Merck, Cas no: S7172386703), and benzethonium chloride (BC) (25, 50, and 100 mg L^{-1}) (Sigma-Aldrich, Cas no: 121-54-0). The cut flowers were kept in a temperature-controlled chamber at 21±1°C temperature, 60±5% relative humidity (RH), and 1000 lux illumination (cool-white fluorescence lamps) for 12-h photoperiod. All solutions were freshly prepared at the beginning of the experiment and no solution was added to the vases during the experiment.

The vase life of flowers was measured as the period that elapsed from the first day when the cut flowers were placed into the vase solutions to the day when they lost their ornamental value (mainly defined by wilting, petal browning, discoloration, pedicel bending, and blueing) (Van Doorn, 1997; Jin et al., 2006; Macnish et al., 2008).

Fresh weight and water uptake were recorded by measuring the weights of the vases without flowers and of flowers separately once in 3 days. Fresh weight change was measured as relative fresh weight and the relative fresh weight (RFW) of stems was calculated as: RFW (%) = $(W_t/W_{t-0})\times100$, where W_t is the weight of stem (g) at t = days 0, 1, 2, etc., and W_{t-0} is the weight of the same stem (g) at t = day 0 (He et al., 2006; Lü et al., 2010). Average daily water uptake was calculated as: water uptake (g $stem^{-1}$ day^{-1}) = $(S_{t-1} - S_t)$, where S_t is the weight of vase solution (g) at t = days 1, 2, 3, etc., and S_{t-1} is the weight of vase solution (g) on the previous day.

The experimental design was a randomized plot design (RPD) with different concentrations of CA, SA, SUA, GA, BC, and DW × three replications × five cut flowers per treatment. The statistical analysis was performed using the SAS general linear model procedure (SAS Institute, 1998). The means were compared using Duncan's multiple range test at the 0.05 probability level.

RESULTS

Vase life

The results showed that the CA (100, 200, and 300 mg L^{-1}), SA (200 and 300 mg L^{-1}), SUA (100 mg L^{-1}), GA (76 mg L^{-1}) and BC (25 and 50 mg L^{-1}) treatments significantly increased the vase life of flowers as compared with the control (Figure 1). The vase life of flowers treated with 100 mg L^{-1} of CA was found 4.74 days longer than that of the control. Reduction in the vase life of flowers was detected at the increasing doses of CA, SUA, GA, and BC.

Relative fresh weight

The relative fresh weights of the flowers in all solutions including the control increased on the first 3 days of the vase life but decreased thereafter. Moreover, the increases in the relative fresh weights of the flowers in the solutions containing different compounds were sharper than that of the control on the first 3 days (Figure 2). It was observed that the increase in relative fresh weight fell below the initial weight in the control on the 6^{th} day of the vase life but was above the initial weight in all other treatments. The highest increase in weight during the vase life was generally obtained in the flowers kept at 100 mg L^{-1} of CA. The RFW increases of the flowers in the vase solutions containing different compounds during the vase life were generally higher than the RFW of the flowers kept in distilled water (control).

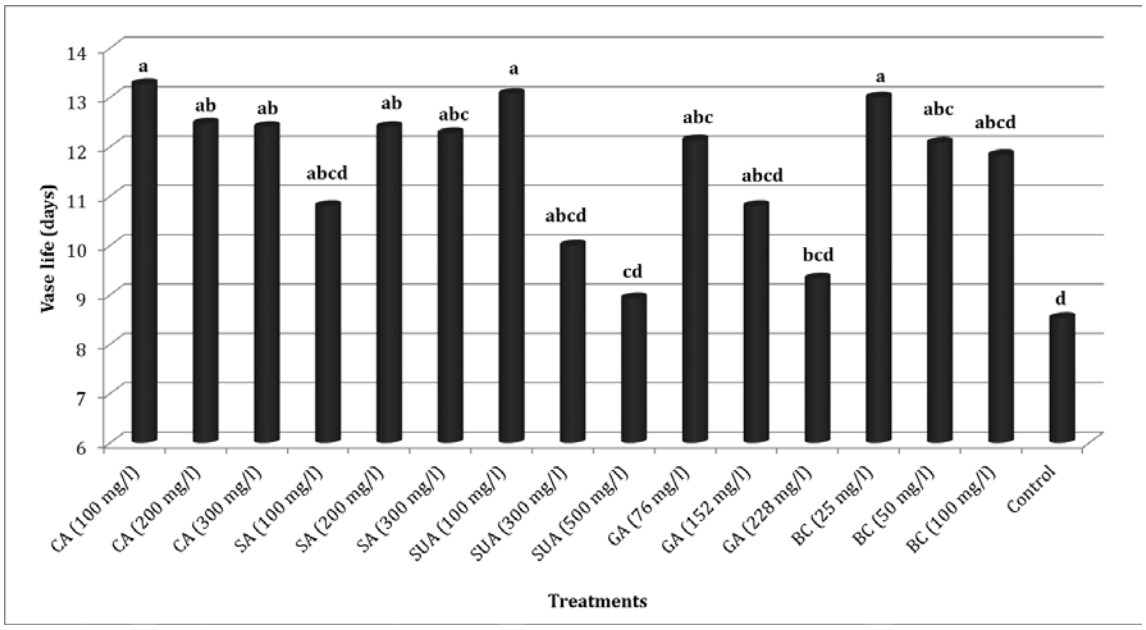

Figure 1. Effects of the treatments on the vase life of cut 'Samourai' rose flowers.

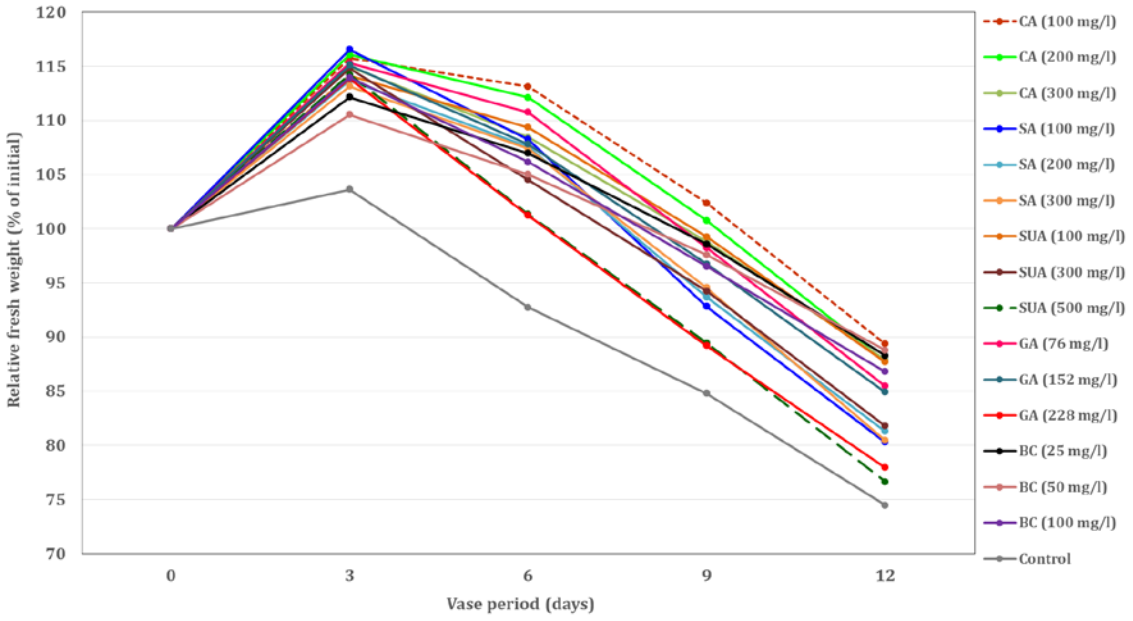

Figure 2. Changes in the relative fresh weights of cut 'Samourai' rose flowers.

Total water uptake

The maximum total solution uptake among the treatments during the vase life was obtained at 200 mg L^{-1} of CA (62.23 g $stem^{-1}$ day^{-1}), whereas the minimum total solution uptake was obtained at 200 mg L^{-1} of SA (35.85 g $stem^{-1}$ day^{-1}). There was generally no significant difference in total solution uptake among the other treatments (Table 1).

Vase solution uptake rate

The solution uptake rate increased during the first 3 days of the vase life in all treatments including the control but gradually decreased until the 9th day thereafter (Figure 3). Although solution uptake slightly increased in some treatments on the 12th day, this

increase was not significant.

Table 1. Effects of the treatments on the total water uptake of 'Samourai' cut rose.

Treatments	Total water uptake (g stem^{-1} day^{-1})
CA 100 mg L^{-1}	53.61 abc
CA 200 mg L^{-1}	62.23 a
CA 300 mg L^{-1}	54.68 abc
SA 100 mg L^{-1}	41.83 abc
SA 200 mg L^{-1}	35.85 c
SA 300 mg L^{-1}	37.14 bc
SUA 100 mg L^{-1}	56.12 abc
SUA 300 mg L^{-1}	60.45 ab
SUA 500 mg L^{-1}	44.68 abc
GA 76 mg L^{-1}	52.52 abc
GA 152 mg L^{-1}	39.01 abc
GA 228 mg L^{-1}	43.29 abc
BC 25 mg L^{-1}	52.23 abc
BC 50 mg L^{-1}	34.48 c
BC 100 mg L^{-1}	37.83 bc
Control	45.51 abc

Means followed by the same letters are not significantly different at the 0.05 probability level.

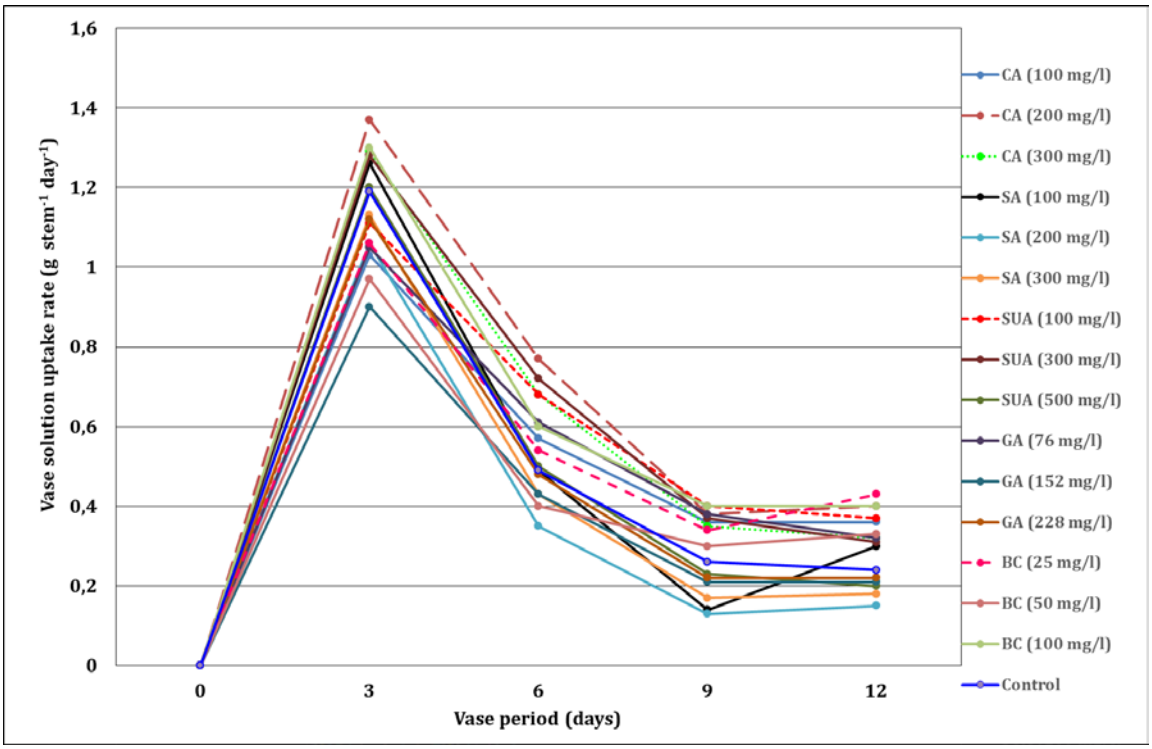

Figure 3. Changes in vase water uptake rate in 'Samourai' rose flowers.

DISCUSSION

CA, an organic acid, is used as an acidifying agent and has a wide sphere of use as an acidulation, antioxidant, flavour enhancement, preservation, plasticizer, and synergistic agent in the food, beverage, pharmaceutical, cosmetics, and other industries (Swain et al., 2012). Organic acids like CA are used both as sources of carbon and energy for cells and in

the respiratory cycle and other biochemical reactions (Teixeira da Silva, 2003). CA extends the vase life in cut flowers by both reducing microbial occlusion in the vase solution and increasing the water conductivity in xylem vessels (Van Doorn, 1997). In this study, the longest vase life was obtained in the solutions containing 100 mg L^{-1} of CA (Figure 1). Furthermore, the solutions containing 200 and 300 mg L^{-1} of CA also significantly prolonged the vase life as compared with the control. The obtaining of the longest vase life, the maximum solution uptake and the highest increase in relative fresh weight from CA out of the treatments may be because citric acid reduced the bacterial growth in the vase solution and increased the water conductivity in xylem vessels. Similarly, the positive effects of CA on the vase life of some cut flowers such as cut rose, lisianthus (Azizi and Onsinejad, 2015) and lilium (Darandeh and Hadavi, 2012) were reported.

SA is a non-toxic organic acid which has physiological and biochemical effects in plants and plays an important role in response to gene expression and stress during senescence (Alaey et al., 2011). In this study, all doses of SA significantly increased the vase life of flowers as compared with the control (Figure 1). The solution containing 200 mg L^{-1} of SA prolonged the vase life by 45.3% as compared with the control. SA was reported to extend the vase life in different cut flower species (Jalili et al., 2011; Kazemi et al., 2011; Mansouri, 2012). Salicylic acid inhibits ethylene synthesis in cut flowers, reduces the sensitivity of flowers to ethylene, decreases the number of bacteria in the vase solution but extends the vase life in cut roses by enhancing the water uptake of flower stems due to its antimicrobial property (Kazemi et al., 2012).

In this study, SUA, GA and BC also significantly prolonged the vase life of flowers as compared with the control. The vase life shortened at the increasing doses of the three compounds each and the increasing doses at the same time led to toxic damage in petals, leaves, and stems as well as to blueing in petals. 100 mg L^{-1} of SUA, 25 mg L^{-1} of BC and 76 mg L^{-1} of GA extended the vase life of flowers by 53.2, 52.4, and 42.2% as compared with the control, respectively. Kazemi et al. (2011) found that SUA delayed petal senescence and flower wilting in lisianthus and doubled the vase life of flowers as compared with the control. The studies on the effects of SUA, GA and BC on vase life in cut flowers are very limited. Moreover, it was reported that benzalkonium chloride (BKC), one of the most important quaternary ammonium salts like BC and used as an active ingredient of many pharmacological formulations, cosmetics, disinfectants, and food preservatives, enhanced water uptake and extended the vase life in cut roses and that these effects were caused particularly by its prevention of bacterial and fungal growth in the vase solution (Li et al., 2015). In this study too, BC is considered to have a similar effect to that of BKC in enhancing the vase life and water uptake of flowers. There is generally a positive correlation between the longevity of the vase life and water uptake in cut flowers, although varying by species (Van Doorn et al., 1991; Li et al., 2015). In our study, the vase life was generally long in the flowers with much water uptake; however, the occurrence of toxic effects and burning especially in stems at high doses shortened the vase life, even though water uptake increased at the high doses of some compounds (e.g., GA and BC).

CONCLUSION

The results obtained in the study revealed that all compounds used improved the vase life of roses as compared with the control but that 100 mg L^{-1} of CA, 100 mg L^{-1} of SUA and 25 mg L^{-1} of BC significantly extended the vase life. The present study also demonstrated that 200 and 300 mg L^{-1} of CA and 200 mg L^{-1} of SA might be used as vase solutions to extend the vase life of cut roses. There will be a need for more detailed studies in the future regarding the effects of SUA, GA and BC on the vase life of cut flowers and cut roses.

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