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Postharvest Life of Cut Gerbera Flowers as Affected by Nano-Silver and Acetylsalicylic Acid

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ABSTRACT

The objective of the study was to determine the effect of Nano-Silver (NS) and acetylsalicylic acid on extending gerbera (*Gerbera jamesonii*) vase-life. For this was used of four levels of acetylsalicylic acid (1, 1.5, 2, 2.5 mM) and five levels of NS (1, 2, 3, 4 and 5 mg L^{-1}). The results of this experiment indicated NS and acetylsalicylic acid treatments inhibited the growth of microorganisms in vase solution and considerably extended the vase-life of cut flowers of gerbera also acetylsalicylic acid (2.5 mM) and NS (5 mg L^{-1}) were the best treatments so that increased vase life of cut flowers in laboratory conditions and decreasing MDA (Malondialehyde) content and ACC-oxidase (1-aminocyclopropane carboxylic acid oxidase) activity. Results of this study suggest that application of NS and acetylsalicylic acid have potential for introducing as novel alternatives instead of common chemicals used in preservative solutions in gerbera flowers.

Key words: Vase life, Nano-silver, acetylsalicylic acid

INTRODUCTION

Gerbera is a member of the composite family (Kazemi *et al*., 2011a). Vase life of cut flower is most attractive and economic components of cut flower. The quality loss of cut flowers may depend on many factors (Kazemi *et al*., 2011b). It is well documented that one of the main causes for inferior cut flowers quality is the blockage of xylem vessels by microorganisms that accumulate in the vase solution or in the vessels (Marandi *et al*., 2011). When the vessels of stems blocked, continuing the water uptake and transpiration by the leaves of cut flowers caused net loss of water of flower and stem tissue (Hassan, 2005). It is reported that there was a negative correlation between the number of bacteria and water conductivity in the stem of cut flower (Kazemi *et al*., 2011a). Cut flowers are sensitive to microbial contamination at the stem base or in the vase solution, consequently were caused to shortening their vase life (Balestra *et al*., 2005). In fact, bacteria in vase water may block vessels on the cut surface (Kazemi *et al*., 2010). Zagory and Reid (1986) found that some bacteria from vase water produced ethylene. There is a correlation between decrease in hydraulic conductance and high number of bacteria per each gram stem fresh weight (Molegn *et al*., 1983). The vase life of cut flowers increased by addition of various antimicrobial compounds such as SA (Kazemi *et al*., 2011a, b, c, d) and silver nanoparticles (Basiri *et al*., 2011) in vase water for reduction of bacterial population in the vase water. SA is a well-known phenol that can prevent ACC-oxidase activity and decrease ROS (Reactive Oxygen Species) with increasing antioxidant enzyme activity (Ansari *et al*., 2007; Mba *et al*., 2007; Mahdavian *et al*., 2007; Canakci, 2008; Kalidage *et al*., 2009). SA (Salicylic acid) could extend the vase life of cut flowers by decreasing ROS (Reactive Oxygen Species) and ethylene to act by Kazemi *et al*.

(2011b,c) germicide the decrease of microbial population (Kazemi *et al*., 2011a, b, c, d). Usage of NS compounds as a pulse and vase solution treatment or cut flowers is relatively new (Solgi *et al*., 2009) and has demonstrated which it is important as an antibacterial agent (Morones *et al*., 2005). The positive effect of a NS pulse treatment was attributed to inhibition of bacterial growth in the vase solution and at the cut stems ends during the postharvest period (Basiri *et al*., 2011). Therefore, in this study, the preservative effects of NS and acetylsalicylic on the vase life of cut gerbera flowers were studied.

MATERIALS AND METHODS

Plant material: *Gerbera* (*Gerbera jamesonii*) were collected from the standard greenhouse (before blooming) (Pakdasht, Tehran, Iran). Selected cut flowers were without any malformations or damage and transport to the laboratory. Stems were trimmed to 40 cm and then were placed in the 250 mL bottle containing preservative solutions after recording the fresh weight. distill water was as control. The treatments were four levels of acetylsalicylic acid (1, 1.5, 2, 2.5 mM) and five levels of NS (1, 2, 3, 4 and 5 mg L^{-1}). The experiment was arranged in a factorial test based on randomized complete design with 6 replications. The vase were placed in chambers at 19°C, relative humidity about 70% and 14 h photoperiod that was maintained using fluorescent lamps (light intensity of 15 ìmol m^{-2} sec^{-1}) at the top of the corolla. The studied traits included Vase life, total chlorophyll content (SPAD reading), anthocyanin leakage, malondialdehyde content, ACC-oxidase activity, Microbial population, water uptake and fresh weight.

Vase life: Vase life was determined as the number of days to wilting of flowers. The flowers were checked once a day for signs of deterioration.

Chlorophyll index: Chlorophyll index was measured by chlorophyll meter (SPAD-502, Minolta Co. Japan), which is presented by SPAD value. Average of 3 measurements from different spots of a single leave was considered.

Determination of anthocyanin leakage: Anthocyanin leakage was measured based on the method of Poovaiah (1979).

Determination of ACC-oxidase activity: ACC oxidase activity was assayed by measuring to the method described by Moya-Lean *et al*. (2004).

Assays of MDA content (Lipid peroxidation): Lipid peroxidation rates were determined by measuring the malondialdehyde equivalents according to Heath and Packer (1968).

Microbe population: Test Microbe population were isolated from vase solutions of Gerbera by measuring to the method described by Zagory and Reid (1986).

Water absorption by cut flowers: The water uptake was calculated by subtracting the mean volume of water evaporated from three control bottle without cut flowers, from the amount of water decreased in bottles containing flowers in experimental course.

Experimental design and statistical analysis: Experiment was arranged in a factorial test based on randomized complete design with six replications. Analysis of variance was performed on the data collected

using the General Linear Model (GLM) procedure of the SPSS software) Version 16, IBM Inc. The mean separation was conducted by tukey analysis in the same software ($p = 0.05$).

RESULTS AND DISCUSSION

Using Nano-Silver (NS) and acetylsalicylic had a significant effect on vase life in the cut flowers, the number of bacteria, Water absorption by cut flowers and ACO (ACC-oxidase) activity in the cut flowers. (Table 1) also application of NS and SA significantly increased vase-life of gerbera cut flowers in compared to the control ($p \leq 0.05$). The effect of 5 mg L^{-1} NS and 2.5 mM SA were better than other treatments in extending vase-life so that this difference was statistically significant. According to the obtained results, addition of NS and SA to vase solutions in all concentrations increased the vase-life of gerbera cut flowers ($p \leq 0.05$). The present results are in agreement with those reported by Kazemi *et al.* (2011a, b, c, d) who used SA to prolong the vase-life of Lisianthus cut flowers. Similarity, Kasahara and Suh (1999) reported that silver- containing compounds extended the vase life of cut roses. It seems that all the treatments statistically increased gerbera cut flowers vase-life in compared to the control ($p \leq 0.05$). Results also indicated that there was significant difference between fresh weight and various concentrations of NS and SA ($p \leq 0.05$). The results for mean comparisons showed (Table 1), the highest fresh weight was observed in 5 mg L^{-1} NS and 2.5 mM SA treatments and the lowest of that in control treatment ($p \leq 0.05$). Increasing of SA and NS levels increased significantly water uptake and fresh weight in vase solution of gerbera cut flowers, while the Microbial population was decreased with the increase in concentrations of SA and NS (Table 1). Maximum solution uptake was observed for flower kept in solution containing 5 mg L^{-1} NS and 2.5 mM SA than control but no significant difference ($p \leq 0.05$) were found among other treatments (Table 1). Kazemi *et al.* (2011a) showed that the treatment of salicylic acid reduced Microbial population in vase solution of cut gerbera flowers and increased water uptake in carnation cut flowers. SA has strong antimicrobial properties against some pathogens and bacteria because it is a phenolics compound. The improved vase-life by using

Table 1: Mean comparisons of chlorophyll content, Vase life, MDA, SOD activity,fresh weight [a], Membrane stability and ACC- oxidase activity in NS, SA treatments treatment

Treatment		Vase life (day)	total chlorophyll (SPAD reading)	ACC- oxidase activity (nmol h^{-1} mL^{-1})	antocyanin leakage (absorption at 525 nm)	MDA (µmol mg^{-1} protein)	water uptake (mL per flower)	colony count (CFU mL^{-1})	Relative fresh weight[b]
Control		7	2.54	145.36	189.32	300.12	80	128	2.010
NS	1	8	3.00	130.12	165.45	174.50	85	100	1.090
(mg L^{-1})	2	9	3.50	120.45	152.01	160.00	90	84	1.064
	3	10	3.45	111.00	140.00	123.10	90	80	1.052
	4	10.5	4.00	96.32	136.45	90.45	100	80	1.042
	5	14	5.02	80.12	111.00	70.56	110	75	1.008
SA (mM)	1	9	4.00	87.12	103.25	92.36	100	75	1.064
	1.5	11	4.90	65.36	76.35	75.36	120	62	1.043
	2	13	6.14	50.12	65.45	72.10	135	46	1.021
	2.5	17	6.91	29.3	60.00	50.65	150	30	1
F-test probabilities									
NS		0	0.05	0	0	0	0	0	0.03
SA		0	0	0	0	0	0	0	0.01

Values are the mean of four replication Mean separation among treatments was done by Tukey; test at $p \leq 0.05$. [a]mLg^{-1} initial fresh weight day^{-1} during first five days of vase-life, [b]gg^{-1} initial fresh weight day^{1} during first five days of vase-life

SA treatment as preservative solutions might be due to their role in inhibiting the microbial growth and preventing bacterial plugging. These results are in agreement with those of Kazemi *et al.* (2011a, c, d) showed that the vase-life of cut flowers increased when placed in solutions with different concentrations of SA. Nano-silver as a pulse and vase solution treatment for cut flowers is relatively new (Solgi *et al.*, 2009) and has demonstrated its importance as an anti-bactericidal agent (Morones *et al.*, 2005). According to Table 1, under the influence of SA, the chlorophyll content greatly increased. Kazemi *et al.* (2011a), observed that increased chlorophyll biosynthesis was related to with SA in the preservative solution ($p<0.05$). El-Tayeb *et al.* (2006) found that Chl a, b and carotenoids increased significantly in SA treated plants in comparison to controls of barley plants. SA treatments were increased pigments content of the plants under non salinity and salinity condition (Table 1). The best treatment in this increase Chlorophyll content was 2.5mM SA. According to Table 1, SA and Nano-silver affected significantly MDA content, ACO activity and anthocyanin leakage. The results indicate that the treatment by 2.5 mM SA and 5 mg L^{-1} NS improved membrane permeability by decreasing ACO activity and decrease accumulation MDA in compared to control. This indicates that with increasing of the concentration of NS and salicylic acid, the ACO activity was decreased. Ethylene as senescence hormone reduces vase-life of cut flowers. SA increase vase-life by inhibiting ethylene synthesis and sensitivity to ethylene action it also inhibits conversion of ACC into ethylene (Khan *et al.*, 2003). Application of silver ions can displace copper ions from the receptor proteins consequently, block ethylene perception, since copper ions have a critical role in ethylene binding upon receptors. (Means *et al.*, 2005; Hedden and Thomas, 2006; Khan, 2006). This effect of silver ion on ethylene was reported by several researchers (Chamani *et al.*, 2005; Wagstaff *et al.*, 2005; Gad and Atta-Aly, 2006; Reggiani, 2006; An *et al.*, 2008; Eo and Lee, 2009; Strader *et al.*, 2009; Sahandi *et al.*, 2011). Our result showed that treatment with SA and NS extends the vase life of cut gerbera flowers also, SA and NS reduced chlorophyll total degradation and preserved chlorophyll total content. These findings are similar to previous results (Kasahara and Suh, 1999; Liu *et al.*, 2009; Solgi *et al.*, 2009; Kazemi *et al.*, 2011a, b,c, d).

CONCLUSION

In conclusion, present results show that SA and NS can provide high preservative level to increase of vase life of cut flowers consequently this study is lead to increasing in quality and vase life of cut flowers of gerbera by decreasing of bacteria concentration, ACO activity and study on various concentrations NS and SA on vase solutions.

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