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EFFECT OF ASCORBIC ACID ON POST-HARVEST VASE LIFE OF CUT LISIANTHUS (*Eustoma grandiflorum L.*) FLOWERS

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ABSTRACT

The vase life of Lisianthus (*Eustoma grandiflorum* L.) cut flowers is relatively short because of some post-harvest problems. Thus, the purpose of this study was to evaluate the efficacy of ascorbic acid (AsA) in extending the vase life of Lisianthus cut flowers. Ascorbic acid is a natural acid and an antioxidant compound which stabilize cell membrane and proteins. Continuous treatment of ascorbic acid at 0, 50, 100 and 200 mg l^{-1} was administered to Lisianthus flowers. The longest vase life of cut flowers (15.50 days) was observed in flowers treated with 200 mg l^{-1} of ascorbic acid. This treatment increased cut vase life seven days longer that the control treatment. The maximum solution uptake (4.133 ml g^{-1} F.W.) was calculated in 200 mg l^{-1} ascorbic acid. The highest dry matter (21.55%) and loss of fresh weight (9.761 g) were obtained in 200 mg l^{-1} ascorbic acid, too. The results of this study showed that ascorbic acid (vitamin C), as a natural anti-oxidant, plays an important role in prolong of cut Lisianthus flowers when it is applied at suitable concentration.

Keywords: post-harvest, Lisianthus (*Eustoma grandiflorum* L.), longevity, ornamental plants, vitamin C, anti-oxidants.

INTRODUCTION

Lisianthus (*Eustoma grandiflorum*) (Gentianaceae), quickly ranked in the top ten cut flowers worldwide due to its rose-like flowers and being available in various colors (Kunitake *et al*., 1995). By nature, Lisianthus initially forms a rosette and grows very slowly during the winter, stems elongate in the spring, and it flowers in summer (Roh *et al*., 1989). Lisianthus has the qualities of an "ideal cut flower" and should continue to increase in popularity throughout the next century.

Microbial contaminations due to bacteria growth in preservative solution reduce vase life of cut flowers (He *et al*., 2006; van Doorn, 1997). Termination vase life for many cut flowers is attributed to wilting (He *et al*., 2006). Stem end blockage is a main factor in the imbalance between water uptake by, and water loss from cut flowers (van Doorn, 1997; da Silva, 2003; He *et al*., 2006). Water balance is a main factor determining quality and longevity of cut flowers (Lü *et al*., 2010). Water uptake and transpiration must be in a balance. Stem end blockage in cut flowers is of three types: physical air emboli (van Doorn and Reid, 1995; van Meeteren *et al*., 2006), microbial (Liu *et al*., 2009), physiological wound-induced (Williamson *et al*., 2002; He *et al*., 2006; Loubaud and van Doorn, 2004). Microorganisms are the most common cause of stem end blockage (van Doorn, 1997). Microbes can also produce ethylene and secrete toxic compounds and accelerate senescence (Williamson *et al*., 2002). Despite cut flowers being kept in water, the blockage leads to the wilting (van Doorn, 1997; He *et al*., 2006). Some compounds improve water uptake in cut flowers and extend vase life.

Ascorbic acid (vitamin C) plays an important role in plant growth and development especially in electron transport system (El-Kobisy*et al*., 2005). Ascorbic acid has been associated with some biological activities in plants such as in enzyme co-factor, antioxidant and electron transporter at the plasma membrane or in the chloroplast (Conklin, 2001). A high level of endogenous ascorbic acid is necessary to maintain the antioxidant system that protects plants from oxidative damage (Cherut, 2009). Some studies were done related to the effect of ascorbic acid on vase life of several cut flowers (Nahed *et al*., 2009; Bedour *et al*., 2011; Abdulrahman *et al*., 2012; Islam *et al*., 2013; Banaee *et al*., 2013; Abri *et al*., 2013). The aim of this study was the effect of different concentrations of ascorbic acid on the longevity of Lisianthus (*Eustomagrandiflorum*) cut flowers.

MATERIALS AND METHODS

Cut Lisianthus (*Eustoma grandiflorum*) flowers were obtained from an economic producer in Tehran, Iran at their optimum developmental stage. They were immediately stood in buckets and transported to the postharvest laboratory. Buckets containing the flower stems were covered with a plastic film shroud to minimize moisture loss during transportation. At the laboratory, stems were re-cut under deionized water. The flowers were selected for uniformity of size, color and freedom from any defects.

The experimental design was a randomized completely blocks design (RCBD) with four treatments containing 0, 50, 100 and 200 mg l^{-1} of ascorbic acid and four replications. In each experiment, five cut Lisianthus flowers were placed into 1000 mL vase filled with 250 mL of preservative solutions including the aforementioned concentrations of citric acid and 500 ml of 3% sucrose. Distilled water was used as a control. The mouths of the pots were covered with a sheet of low density polyethylene film to minimize evaporation and to prevent contamination. The flowers were kept in a vase life room under the following conditions: 20 ± 2°C, relative humidity of 60-70%, 12 µmol $m^{-2}s^{-1}$ light intensity (cool white florescent tubes) and a daily light period of 12 h.

Criterion for the end of vase life was the time that flowers were showing symptoms of petals wilting or curling. Vase life was the period from the time of putting

the cut flowers into the second preservative solution until the end of vase life.

Solution uptake was calculated as following formula:

Solution uptake = 500 - (volume of rest solution at the end day + mean of evaporation of 4 vase at that time

Fresh weight was measured with a digital balance. The first measurement was calculated exactly after the treatment and the last one was calculated at the last day of vase life. Loss of fresh weight (g) was obtained by following formula: fresh weight in first day of experiment - fresh weight at the end of vase life. To determine the dry matter, cut flowers were exposed at 70°C for 48 h in an oven and calculated by a digital balance. Dry matter percentage was obtained by following formula:

Dry matter percentage = Dry weight / fresh weight × 100

Data were subject to analysis of variance (ANOVA) and means were compared by the least significant difference (LSD) test at $p \leq 0.05$ using SPSS statistical software.

RESULTS AND DISCUSSIONS

In the present study, different concentrations of ascorbic acid (vitamin C) was applied as the main sources of variation. Based on our findings, ascorbic acid could extend the vase life of cut Lisianthus (*Eustoma grandiflorum* L.) flowers. Studied characteristics were vase life, solution uptake, loss of fresh weight and dry matter percentage. The results are summarized in Tables-1 and 2. Ascorbic acid increased vase life of cut Lisianthus (*Eustoma grandiflorum* L.) flowers significantly ($p \leq 0.05$) (Table-1). The mean comparison among treatments showed that the vase life was the highest (15.50 days) in cut flowers treated with 200 mg l^{-1}ascorbic acid (Table-2). This treatment increased the vase life of cut flowers about 2 times more than that of control cut flowers (8.40 days). Positive effect of ascorbic acid on post-harvest of several cut flowers has been shown (Muhammad *et al*., 2001; Bedour *et al*., 2011; Abdulrahman *et al*., 2012; Abri *et al*., 2013; Banaee *et al*., 2013). Study of Abdulrahman *et al*. (2012) on the effect of ascorbic acid on vase life of snapdragon (*Antirrhinum majus* L.) demonstrated that ascorbic acid at 150 mg l^{-1} increased vase life from 6.96 in control treatment to 9.75 days. Similar to our findings, Nahed *et al*. (2011) revealed that the best results for flowering parameters of gladiolus plants were obtained by use of ascorbic acid at 200 mg l^{-1}. Also, Bedour *et al*. (2011) showed that the 200 mg l^{-1} ascorbic acid improved growth and vase life of cut gladiolus flowers. Investigation of Abri *et al*. (2013) on cut rose flowers revealed that 4 mM ascorbic acid had the maximum vase life 8 days as compared to the days in the control. Vase life of cut rose and cut *Alpiniapurpurata* flowers treated with ascorbic acid was significantly longer than that of control flowers (Jin *et al*., 2006; Ieamtim *et al*., 2008). These researchers found that ascorbic acid increased the vase life of cut flowers by reducing the respiration rate and ethylene production. Study of Banaee *et al*. (2013) on the effect of ascorbic acid on the longevity of cut gerbera flowers showed that the treatment containing 100 mg l^{-1} this organic compound resulted in the maximum vase life. Contrary to our findings, some studies did not shown the positive effect of ascorbic acid on prolonging the vase life of cut flowers (Islam *et al*., 2013). The use of other organic compounds such as citric acid and malic acid for increasing the vase life of cut flowers has been reported by some researchers (Kazemi *et al*., 2010; Darandeh and Hadavi, 2012; Jamshidi *et al*., 2012).

Table-1. Analysis of variance (ANOVA) of the effect of different concentrations of ascorbic acid on various traits in cut Lisianthus (*Eustomagrandiflorum* L.) flowers.

Source of variations	df	Vase life	Solution uptake	Loss of fresh weight	Dry matter
Treatment	3	16.87*	1.83**	9.89**	12.54**
Error	9	6.92	0.33	0.81	0.90
CV (%)		21.13	13.44	12.7	9.67

**: significance level at 1%, *: significance level at 5%

Table-2. Mean comparison of the effect of different concentrations of ascorbic acid on various traits in cut Lisianthus (*Eustomagrandiflorum* L.) flowers*.

Ascorbic acid (mg l^{-1})	Vase life (day)	Solution uptake (ml g^{-1} F.W.)	Loss of fresh weight (g)	Dry matter (%)
0	8.40[b]	2.55[d]	5.49[d]	16.51[b]
50	14.25[a]	3.28[c]	6.59[c]	20.69[a]
100	12.27[ab]	3.83[ab]	7.16[b]	19.72[a]
200	15.50[a]	4.13[a]	9.76[a]	21.55[a]

*Values in each row that are followed by the same letter are not significantly different by LSD test.

Solution uptake was affected by ascorbic acid ($p \leq 0.01$) (Table-1). Cut flowers in the solution containing 200 mg l^{-1} citric acid showed the maximum solution uptake rate (4.13 ml g^{-1} F.W.) (Table-2). All concentrations of ascorbic acid improved solution uptake than the control (2.55 ml g^{-1} F.W.) (Table-2). Preferential solution uptake of cut flowers incubated in ascorbic acid suggesting a possible decrease in xylem blockage due to reduced microbial growth. Positive effect of ascorbic acid may be attributed to its antimicrobial activity that reduce bacterial population and resulted in increase the vessels conductivity and water uptake. Low water uptake by cut flowers is often due to occlusions located mainly in the basal stem end (He *et al*., 2006) and microorganisms and their decay products are a common cause of stem end blockage (van Doorn, 1997; Williamson *et al*., 2002). In many cut flowers, suppression of microbial growth in the vase solution results in delayed wilting (van Doorn, 1997). Data analysis showed that the effect of different concentrations of ascorbic acid was significant on the loss of fresh weight ($p \leq 0.01$) (Table-1). Mean comparison of the effect of ascorbic acid on the loss of fresh weight revealed that the 200 mg l^{-1} ascorbic acid was the best treatment (Table-2). Similar results were obtained by some researchers (Abdulrahman *et al*., 2012). Improving fresh weight by ascorbic acid is probably due to ability of this compound to delay water content loss and its antimicrobial activity.

Data analysis showed that the effect of ascorbic acid was significant on dry matter (Table-1). Results showed that ascorbic acid in suitable concentration increased dry matter of cut Lisianthus flowers. Dry weight increased in case of 200 mg l^{-1}ascorbic acid (21.55%) compared to the control (16.51%) (Table-2). Positive effect of ascorbic acid on dry matter is probably due to its antimicrobial properties. The present results are in agreement with those reported by Abdulrahman *et al*. (2012) and Banaee *et al*. (2013).

CONCLUSIONS

Some organic acids increase the vase life of cut flowers. Vase life of cut Lisianthus (*Eustoma grandiflorum* L.) flowers is relatively short. Ascorbic acid is a natural acid and an antioxidant compound. The maximum post-harvest longevity of cut flowers was observed in flowers treated with 200 mg l^{-1} of ascorbic acid. The highest solution uptake was obtained in 200 mg l^{-1} ascorbic acid. This study revealed that ascorbic acid (vitamin C), as a natural anti-oxidant, plays an important role in prolong of cut Lisianthus flowers when it is used at proper concentration.

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