Int. J. Pure Appl. Sci. Technol., 13(2) (2012), pp. 32-41

International Journal of Pure and Applied Sciences and Technology

ISSN 2229 - 6107

Available online at www.ijopaasat.in

Research Paper

Effect of Sucrose and Ascorbic Acid Concentrations on Vase Life of Snapdragon (*Antirrhinum Majus* L.) Cut Flowers

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(Received: 9-10-12; Accepted: 20-11-12)

Abstract: *The vase life of snapdragon cut spike flower (Antirrhinum majus L.) is short due to some post harvest problems leading to its low postharvest quality. Flower longevity is varied in different cultivars of snapdragon. But cause of short vase life was most reported to be loss of carbohydrate content or stem vessel blockage. Therefore this experiment was carried out to investigate the effect of different concentrations effect of sucrose and ascorbic acid on the vase life of snapdragon cut spike flowers (Antirrhinum majus L.). Cut spikes were kept in solutions consisted of two levels of sucrose (0.25 and 0.50 g l^{-1}), three levels of ascorbic acid (50, 100, 150 g l^{-1}) and distillated water as control were applied in a factorial arrangement, carried out in a complete randomized design in physiology laboratory of horticulture department, Faculty of Agricultural and Forestry, Dohuk University. Flowers were kept in glass vases containing 250 ml solutions. The result showed that 0.5 g l^{-1} of sucrose significantly increased time to stem bending, fresh and dry weight, percentage of change in fresh weight and total carbohydrates, and vase life of cut flower, while ascorbic acid at 150 g l^{-1} significantly increased vase life, fresh weight and percentage of total carbohydrates, as for interaction noted that 0.5 g l^{-1} sucrose + control treatment significantly increased cut flowers vase life, bending time and percentage in fresh weight change, but 0.5 g l^{-1} sucrose + 150 g l^{-1} ascorbic acid increased fresh and dry weight, and total carbohydrates percentage in snapdragon cut spike flowers.*

Keywords: Sucrose, Ascorbic acid, vase life, Snapdragon *(Antirrhinum majus* L.*)*, Cut flowers.

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1. Introduction

Snapdragon (*Antirrhinum majus*) belongs to Scrophalariaceae family, the genus of *Antirrhinum* which its name is derived from two words (Anti) which means like or as and (rhinas) which means nose which refers to the shape of the flower which looks like a snapdragon, consists of 30 species established in the basin of Mediterranean sea (Badir *et.al.*, 1998).This plant is one of the important winter annuals which are planted abundantly in gardens because of its flowers beauty and its fitness for commercial plucking. It is worth mentioning that snapdragon represents 3% out of 70% of the plants used commercially as plucking flowers in the field of manufacturing flowers in European countries (Awadh and Dhwa, 1985). This plant is desirable for use as cut flowers because of their wide range of petal colors and fragrances. However, the vase life of snapdragon is relatively short (Nowak, 1981; Woltering and Van Doorn, 1988 and Serek et al., 1995)

Sugars play important role in plants as substances for respiration and cell walls as osmolytes. Since the amount of sugar contained in cut flowers is limited, the addition of sugars such as sucrose to vase water is effective in improving the vase life of some cut flowers (Halevy and Mayak, 1979). Improvement in the post harvest life of flowers by sugar loading has been demonstrated in a number of ethylene-sensitive flower systems (Mayak and Dilley, 1976; Monteiro et al., 2002; Pun and Ichimura, 2003; Verlinden and Vicente Garcia, 2004; Van Doorn, 2004). Very little is known about the role of sugars in ethylene-insensitive flower senescence (Eason et al., 2002). Among the different types of sugars, sucrose has been found to be the most commonly used sugar in prolonging vase life of cut flowers and the exogenous application of sucrose supplies the flowers with much needed substrates for respiration and does not only prolongs vase life, but enables cut flowers harvested at the bud stage to open, which otherwise could not occur naturally (Pun and Ichimura, 2003). On other hand, sucrose pulsing increased the vase life of different cut flowers. Different concentrations of sucrose had been investigated by Butt (2005) on two cultivars of *Rasa hybirida* and results showed that sucrose at 25 g l^{-1} extended the vase life by 8.2 days in var. Whisk Mc and 7.5 days in var. Trika as compared to 5.3 days in control. Also Pun *et al*. (2005) treated cut spry carnation by different concentrations of sucrose ranging from 0 -7.5% and found that 5.0% sucrose recorded the best vase life and delayed the climacteric ethylene in petals. Ichimura, (2008) examined the effects of sucrose application on the vase life of cut snapdragon flowers with concentrations at 50, 75, 100 or 125 g l^{-1} markedly promoted and extended the vase life of flower spikes and clear that the sucrose alone extended the vase life of cut flowers only with increasing concentrations of sucrose up to 100 g l^{-1} and the treatment 50 g l^{-1} was optimum concentration to increased the sugar concentrations of petals and suppressed ethylene production of florets. Shahri et al. (2010) show that sucrose was found to enhance vase life in cut spikes of *Aquilegia vulgaris* and *Consolida ajacis* cv. Violet blue; besides it improves blooming, fresh and dry mass of flowers.

Ascorbic acid (vitamins C) is a product of D-glucose metabolism in higher plants which affect on plant growth and development, and play a role in electron transport system (El-Kobisy et al., 2005). Smirnoff *et al.*, 2001 proposed a biosynthetic pathway and identified novel some enzymes. They also reported that ascorbate is synthesized from Lgalactose via GDP-mannose and GDP- L galactose. Ascorbic acid also has been associated with several types of biological activities in plants such as in enzyme co factors, antioxidant, and as a donor / acceptor in electron transport at the plasma membrane or in the chloroplast (Conklin, 2001). A high level of endogenous ascorbate is essential effectively to maintain the antioxidant system that protects plants from oxidative damage (Cherut, 2009). Nahed *et al.* (2009) refer that the best results for flowering parameters of gladiolus plants were obtained by application ascorbic acid at 200 ppm showed a stimulatory effect on all chemical constituents. Bedour *et al.* (2011) show that 200 ppm ascorbic acid, improved growth, delayed flowering opening of vase life and stimulated accumulation of carbohydrate.

The objective of this work was to evaluate the effect of different concentration of sucrose, ascorbic acid alones and its combinations on extending vase life and some characteristics of cut snapdragon (*Antirrhinum majus* L.) spike flowers.

2. Materials and Methods

Flowers were obtained in a morning of spring (May) in 2011. Thereafter, they were kept under shade in the flower mart until being transported within 6 hours to the physiology laboratory in horticulture department, Faculty of Agricultural and Forestry, Dohuk University. To minimize moisture loss of flowers were covered with plastic film during transportation. At laboratory the end of flower stems were re-cut by ≥10 cm and cut flowers with about 20 cm long were used in the experiment. The experiment took place in a complete randomized design (CRD).

Vase solutions were freshly prepared at the beginning of the experiment. Solutions consisted of tow treatments include Sucrose concentrations at 0.25, 0.50 g l^{-1}, Ascorbic acid concentrations at 50, 100, 150 g l^{-1} alone and in combinations and distillated water as control. Flowers were kept in glass vases containing 250 ml solutions. Pot mouths were then covered with a sheet of polyethylene film to minimize evaporation and to reduce further contamination. After recording the initial fresh weight, flowers were placed in glass vases filled with the preservative solutions. The flowers were then kept in a controlled room under the following conditions: 12 h photoperiod by fluorescent lamps, constant temperature of 25±2°C and relative humidity of 60±10%.

Main measured parameters which were supposed to be related to the effect of sucrose, ascorbic acid alones and its combinations on vase life and some characteristics of cut snapdragon spike flowers during or at the end of the study as follows:

(1) Vas life (day): was calculated number of days since picking flowers or start of treatment and when signs of petals damage (petals colored) (Han, 2003).
(2) Time of spike stem curvature (day): calculated as the number of days since picking flowers and even curvature of spike stem.
(3) Change in fresh weight (%): was calculated according to the proportional relationship described by the following (Setyadjit *et al.*, 2004)

$$\text{Change in fresh weight (\%)} = \frac{\text{Fresh weight at the end of vase life}}{\text{Fresh weight at the beginning of experiment}} * 100$$

(4) Fresh weight of flowers at the end of vase life (g).
(5) Dry weight of flowers (g): samples were dried in paper bags in an electric oven for two days at a temperature of 70 c.
(6) Percentage of dry matters in flowers (%).
(7) Percentage of total carbohydrates in the flowers (%).

The experiment was applied by using randomized complete block design (RCBD) of two factors in three replicates. The angular conversion for the results of germination percentages and then they have been analyzed by SAS program (2001). Duncan test under probability level (5 %) has been used for means comparing.

3. Results and Discussions
3.1 Vase Life (Days)

The vase life of snapdragon cut spike flowers was significantly extended by the different concentrations of sucrose used (Table 1). The vase life was longer in sucrose and the longest vase life was attained when sucrose was applied at 0.5 g l^{-1}, which gave 10.20 days in comparison to 9.09 and 8.38 days for sucrose at 0.25 g l^{-1} and control treatment respectively. The previous results show that adding sucrose extended the vase-life and improved the quality of Snapdragon cut flowers. Adding a carbohydrate source such sucrose to the holding solution resulted in an extension of vase-life if growth of microorganisms was controlled and the increased flower longevity in the acidic solutions was due to the inhibition of vascular blockage and increased water absorption (Marousky,1972). Dissolved sugars in cells of petals are osmotically active substances that are drawn into the corolla-cells making the cells turgid with hydrolyzed sugars ready for respiration (Ichimura and Hismatsu, 1999). Similar findings were obtained by Ichimura (1998), Beura et *al*. (2001) and Dineshbabu *et al*. (2002). Ascorbic acid resulted in the lowest vase life compared to sucrose at different concentrations used. The vase life was longer in ascorbic acid at 150 g l^{-1} which resulted in 9.64 days followed by 50 g l^{-1} (9.36 days) compared to other concentrations this results agreement with Bedour *et al.* (2011) show that 200 ppm ascorbic acid, improved growth, delayed flowering opening of vase life such positive increase could be explained by the fact that vitamins like ascorbic acid considered as a bio-regulators compounds which in little concentration exerted profound influence upon quality and long vase life and may be due to the pro motive effect of vitamins on most chemical constituents of plants (Muhammad *et al.*, 2001). Also the interaction between different concentrations of sucrose and ascorbic acid on vase life was significant at 0.5 g l^{-1} sucrose without ascorbic acid or with control (11.30 days) while the lowest vase life was in control treatment without adding sucrose and ascorbic acid (6.96 days).

Table (1): Effect of sucrose and ascorbic acid concentrations and their interactions on the vase life (days) of cut snapdragon (*Antirrhinum majus*) flowers.

Sucrose Conc. (gl^{-1})	**Ascorbic acid Conc. (g l^{-1})**				**Effect of Sucrose**
	0	**50**	**100**	**150**	
0	6.96 e	8.83 cd	8.00 d	9.75 bc	8.38 c
0.25	8.37 d	9.58 bc	9.00 cd	9.42 bc	9.09 b
0.5	11.30 a	9.68 bc	10.07 b	9.75 bc	10.20 a
Effect of Ascorbic acid	8.88 b	9.36 ab	9.02 b	9.64 a	

Note: 1. Each number represents a mean of 3 replicates and 3 plants for each replicate.
2. Numbers carrying the same letter has no significant differences according to Duncan test under probability level of 5%.

3.2 Bending Time of Spike Stem (Day)

Results of (Table 2) showed that the bending time of snapdragon cut flowers were significantly extended as a result of using sucrose as compared to the control. The bending time was longer in 0.25 and 0.5g .l^{-1} which resulted in 7.21 and 7.19 days respectively in comparison with 6.66 days of the control ones. As for ascorbic acid noted that different concentrations of its had a significant effects on bending time of spike stem as compared with control, the longer time was 7.23 days in 50 g l^{-1} and this time decreased with increasing of the ascorbic acid concentration in the solution. And noted from the interaction that the time of spike stem bending was 8.30 days in solution contain 0.5 g l^{-1} with control treatment, while the shorter time was 5.98 days in 0.5 g l^{-1} sucrose with 150 g l^{-1}ascorbic acid.

Table (2): Effect of sucrose and ascorbic acid concentrations and their interactions on time of spike stem bending (day) of cut snapdragon (*Antirrhinum majus*) flowers.

Sucrose Conc. (g l^{-1})	Ascorbic acid Conc. (g. l^{-1})				Effect of Sucrose
	0	50	100	150	
0	5.31 g	6.81 de	6.75 de	7.79 ab	6.66 b
0.25	6.31 ef	7.96 ab	7.26 b-d	7.29 b-d	7.21 a
0.5	8.30 a	6.91 c-e	7.55 bc	5.98 f	7.19 a
Effect of Ascorbic acid	6.64 b	7.23 a	7.18 a	7.02 a	

Note: 1. Each number represents a mean of 3 replicates and 3 plants for each replicate.
2. Numbers carrying the same letter has no significant differences according to Duncan test under probability level of 5%.

3.3 Change in Fresh Weight (%)

With respect to holding solution effect on maximum increase of fresh weight of snapdragon cut flowers, data presented in (Table 3) show that a higher fresh weight was maintained in florets from spikes placed in 0.5 g l^{-1} sucrose than those of 0.25 g l^{-1} sucrose and control. Relevant values for the maximum increase in fresh weight percentage were 75.44 %. However, the lowest values of this parameter accompanied the control, which was 60.95% during vase-life. The major effect of sucrose on snapdragon flowers is probably due to the increase in osmotic concentration of the flowers and by this, to improve water uptake, but sucrose may also affect the nutrition or energy supply of the flowers. Sucrose may have, also, a beneficial effect on maintaining higher fresh weights in cut flowering stems by inducing stomata closure and thus, reducing water loss (Marousky, 1972). Furthermore, pulsing snapdragon flowers in sucrose vases resulted in higher longevity period, which might indicate that sucrose played a critical role in promoting water absorption and metabolic processes within flower (Kim and Lee, 2002). Statistically no significant differences existed have been recorded from fresh weight percentage of cut flowers among the different concentrations used of ascorbic acid. The data interaction show that the biggest percentage of the change in fresh weight reached 81.32% and 80.80% at keeping flowers in a solution consisting of 0.5 g l^{-1} sucrose and control followed by 0.5 g l^{-1} sucrose + 50 g l^{-1} ascorbic acid respectively, while less values were between different concentrations of ascorbic acid with control treatment.

Table (3): Effect of sucrose and ascorbic acid concentrations and their interactions on Change in fresh weight (%) (*Antirrhinum majus*) flowers

Sucrose Conc. (g l^{-1})	Ascorbic acid Conc. (g l^{-1})				Effect of Sucrose
	0	50	100	150	
0	60.82 d	59.02 d	59.26 d	64.69 cd	60.95 c
0.25	65.76 cd	73.12 b	71.78 bc	74.22 b	71.22 b
0.5	81.32 a	80.80 a	71.29 bc	68.34 bc	75.44 a

Effect of Ascorbic acid	69.30 a	70.98 a	67.44 a	69.08 a	

Note: 1. Each number represents a mean of 3 replicates and 3 plants for each replicate.
2. Numbers carrying the same letter has no significant differences according to Duncan test under probability level of 5%.

3.4 Fresh Weight of Flowers (g)

It is evident from the data presented in (Table 4) that sucrose and ascorbic acid had a significant effect on the fresh weight of snapdragon cut flowers. The maximum fresh weight 13.54 gm was recorded in 0.5 g l^{-1} sucrose, closely followed by control and 0.25 g l^{-1}sucrose. The major effect of sucrose on snapdragon flowers is probably due to the increase in osmotic concentration of the flowers and by this to improve water uptake, but sucrose may also affect the nutrition or energy supply of the flowers. Sucrose may have, also, a beneficial effect on maintaining higher fresh weights in cut flowering stems by inducing stomata closure in the leaves and thus, reducing water loss (Marousky, 1972). As for ascorbic acid noted that the significant maximum fresh weight 13.60 gm was recorded in 150 g l^{-1}, while the minimum weight 10.43 gm was noted in 50 g l^{-1}. The interaction between sucrose and ascorbic acid also had significant effects the highest fresh weight was 16.83 gm when put the cut flowers in solution consist of 0.5 g l^{-1}sucrose and 150 g l^{-1} ascorbic acid.

Table (4): Effect of sucrose and ascorbic acid concentrations and their interactions on fresh weight (g) of cut snapdragon (*Antirrhinum majus*) flowers.

Sucrose Conc. (g l^{-1})	**Ascorbic acid Conc. (g l^{-1})**				**Effect of Sucrose**
	0	**50**	**100**	**150**	
0	13.27 b	10.33 c	10.00 c	11.70 bc	11.33 b
0.25	9.53 c	9.93 c	9.67 c	12.27 bc	10.35 b
0.5	13.07 b	11.03 bc	13.23 b	16.83 a	13.54 a
Effect of Ascorbic acid	11.96 b	10.43 c	10.97 bc	13.60 a	

Note: 1. Each number represents a mean of 3 replicates and 3 plants for each replicate.
2. Numbers carrying the same letter has no significant differences according to Duncan test under probability level of 5%.

3.5 Dry Weight of Flowers (g)

Data presented in (Table 5) show that a significant higher dry weight was maintained in florets from spikes placed in control and 0.5 g l^{-1} sucrose showed the highest dry weight which recorded approximately 3.76 gm and 3.24 gm, while the lowest dry weight 3.11gm was recorded in 0.25 g l^{-1}. Statistically no significant differences existed have been recorded from dry weight of cut flowers among the different concentrations used of ascorbic acid. But for the interaction between sucrose and ascorbic acid; the high dry weight was 4.52 gm when put cut flowers in solution consist of 0.5 g l^{-1}sucrose and 150 g l^{-1} ascorbic acid.

Table (5): Effect of sucrose and ascorbic acid concentrations and their interactions on Dry weight of flowers (g) of cut snapdragon (*Antirrhinum majus*) flowers

Sucrose Conc. (g l^{-1})	Ascorbic acid Conc. (g l^{-1})				Effect of Sucrose
	0	50	100	150	
0	3.76 a-c	3.95 ab	3.94 ab	3.37 a-c	3.76 a
0.25	3.01 bc	3.56 a-c	2.84 bc	3.04 bc	3.11 b
0.5	2.95 bc	2.93 bc	2.57 c	4.52 a	3.24 ab
Effect of Ascorbic acid	3.24 a	3.48 a	3.12 a	3.64 a	

Note: 1. Each number represents a mean of 3 replicates and 3 plants for each replicate.
2. Numbers carrying the same letter has no significant differences according to Duncan test under probability level of 5%.

3.6 Percentage of Dry Matters in Flowers (%)

The data recorded for percentage of flowers dry matter are given in (Table 6). In this case the results were significantly affected by the different concentrations of sucrose ($P \leq 0.05$). Average values for sucrose conclude that maximum percentage 76.24 % was achieved in 0.5 g l^{-1}, closely followed by 0.25 g l^{-1} was 69.73%. Minimum percentage of dry matters 66.29% was for control treatment, similar findings were obtained by Shahri *et al.* (2010) show that sucrose was found to enhance vase life in cut spikes of *Aquilegia vulgaris* and *Consolida ajacis* ; besides it improves blooming, fresh and dry mass of flowers. No significant differences have been recorded among the different concentrations of ascorbic acid used in this study as compared with control treatment. The interaction between 0.5 g l^{-1} sucrose and 100 g l^{-1} ascorbic acid recorded the highest percentage of flowers dry matters 80.67%.

Table (6): Effect of sucrose and ascorbic acid concentrations and their interactions on dry matters (%) of cut snapdragon (*Antirrhinum majus*) flowers

Sucrose Conc. (g l^{-1})	Ascorbic acid Conc. (g l^{-1})				Effect of Sucrose
	0	50	100	150	
0	71.59 cd	61.87 f	60.53 f	71.17 cd	66.29 c
0.25	68.55 de	64.32 ef	70.80 cd	75.25 bc	69.73 b
0.5	77.24 ab	73.65 b-d	80.67 a	73.39 b-d	76.24 a
Effect of Ascorbic acid	72.46 a	66.61 b	70.67 a	73.27 a	

Note: 1. Each number represents a mean of 3 replicates and 3 plants for each replicate.
2. Numbers carrying the same letter has no significant differences according to Duncan test under probability level of 5%.

3.7 Total Carbohydrates Flowers (%)

It can be noticed from (Table 7) that there are significant effects of sucrose and ascorbic acid in increasing carbohydrates amount in flowers. Average values for sucrose conclude that maximum percentage of total carbohydrates 1.15% was achieved in 0.5 g l^{-1}, closely followed by control treatment was 0.97%. Minimum percentage was 0.62 % in sucrose at 0.25 g l^{-1} this results agreement with Ichimura, (2008) that examined the effects of sucrose application on the vase life of cut snapdragon flowers. Ascorbic acid at concentration 150 g l^{-1} gave a significant increasing in total carbohydrates percentage 0.97% as compared with other concentrations except control treatment that gave maximum values of total carbohydrates percentage 0.98% this results agreement with Bedour *et al.* (2011) show that 200 ppm ascorbic acid, improved growth and stimulated accumulation of carbohydrate, on other hand the highest amount of carbohydrates was obtained in the case of interaction between sucrose at 0.5 g l^{-1} and ascorbic acid at 150 g l^{-1} with control 1.39% which significantly differed from other interactions .

Table (7): Effect of sucrose and ascorbic acid concentrations and their interactions on Percentage of total carbohydrates in (%) of cut snapdragon (*Antirrhinum majus*) flowers.

Sucrose Conc. (g l^{-1})	**Ascorbic acid Conc. (g l^{-1})**				**Effect of Sucrose**
	0	**50**	**100**	**150**	
0	0.92 d	0.76 ef	0.95 d	1.25 b	0.97 b
0.25	0.75 ef	0.75 ef	0.71 f	0.26 g	0.62 c
0.5	1.28 b	0.80 e	1.13 c	1.39 a	1.15 a
Effect of Ascorbic acid	0.98 a	0.77 c	0.93 b	0.97 ab	

Note: 1. Each number represents a mean of 3 replicates and 3 plants for each replicate.
2. Numbers carrying the same letter has no significant differences according to Duncan test under probability level of 5%.

4. Conclusions:

The results showed that only use of sucrose at 0.5 g l^{-1} has a positive effect on the more evaluated traits, so that it has caused an increasing in vase-life of flowers, time to stem bending, fresh and dry weight of cut flowers, percentage of change in fresh weight and total carbohydrates, while ascorbic at 150 g l^{-1} significantly increased the vase life, fresh weight and percentage of total carbohydrates, as for interaction noted that 0.5 g l^{-1} sucrose + control significantly increased cut flowers vase life, bending time and percentage of fresh weight change, but 0.5 g l^{-1} sucrose + 150 g l^{-1} ascorbic acid increased fresh and dry weight and percentage of total carbohydrates in snapdragon cut spike flowers.

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