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Vase life of *Solidago canadensis* L. cut flowers as affected by some chemical preservatives

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Abstract: This work was carried in the laboratory of the Department of Ornamental Plants and Woody Trees, National Research Centre to investigate the effect of using some chemical preservative solutions on the vase life of cut flowers of *Solidago Canadensis*, L. cv. "Tara ".Treating solidago cut flowers with 0.4 mM STS for 6h.alone gave the highest values in vase life (days). Using 0.4 mM STS with or without sucrose recorded the highest level of water balance after 6th day during shelf life period in the 1st season and after 4 days in the 2nd season. Treating solidago cut flowers with 300 ppm 8-HQS + 40 g/l sucrose gave the highest maximum increase in fresh weight% in both seasons as well as maximum values of chl a, b and carotenoids and highest values of total and non-reducing sugars.Using 50 ppm BA for 24h.then placed in 200 ppm 8-HQS gave the highest level of water balance after 6 days during shelf life period in both seasons.
Key words: Solidago, cut flowers, longevity, preservative solutions.

Introduction

Golden rod (*Solidago canadensis* L., Asteraceae), a landscape weedy plant species found commonly within its native range in North America, is also considered an ornamental plant [1]. It is being appreciated as a landscaping plant for years. Solidago is an excellent cut flower commonly used for indoor decoration in vases and bowls. Demand for Solidago has been dramatically over the past three years, it is a new crop among the top 25 most popular cut flowers around the world. This new crop could be adopted to be produced under natural Egyptian conditions, with minimum environmental control, for export to the European markets during the off-seasons in winter and early spring months[2]. Cut flowers have a limited shelf life and have traditionally been cultivated close to marketing centers so that consumers might enjoy maximum utilization of the flowers. The problem with the distribution is that flowers nowadays have to be transported all over the world. The vase life of the flowers must be extended to provide the consumer with equivalent flower quality[3]. It is stated that microbial contamination is a main cause of limiting the vase life of cut flowers[4]. Different chemicals as aluminum sulphate and 8-hydroxyquinoline sulphate have been used in vase life of cut flowers mainly by improving their water uptake and reducing transpiration, thereby promote the vase life of them. The pulse application of silver thiosulphate (STS) was effective treatment for extending vase life of cut flowers [5,6,7]. The effect of different concentrations of various chemical properties on the postharvest life of cut flowers are variable depend on plant species and the applied chemicals. It is well documented that silver is ethylene inhibitor and germicide. BA and GA3 both prolonged vase life of chrysanthemum[8], BA inhibited ethylene production, it is the main factor regarding senescence of cut.

The use of floral preservative solution 8-hydroxy quinolone sulphate (8-HQS) as ethylene antagonist combined with 7% sucrose increased vase life of *Rosa domascena* cv. Trigintipetala and retarded the chlorophyll as well as carbohydrate degradation[9]. The aim of this study was to investigate the effect of using some chemical preservative solutions on the vase life of solidago cut flowers, in order to improve their quality and extend the shelf life period.

Materials and Methods

The experiment was carried out at the Laboratory of Ornamental Plants and Woody Trees Department, National Research Centre during two successive seasons (2008 and 2009). The aim of this study was to investigate the effect of using some chemical preservative solutions on the vase life of solidago cut flowers (*Solidago canadensis*, L C.V. "Tara"), in order to improve their quality and extend the shelf life period. The flowers were obtained directly from a commercial growing farm "Floramix Farm.", they were cut early in the morning and potted in icebox collar and transported to the laboratory within one hour, pre-cooling was the first step to preparing the stems, then 5 cm from the bases were cut as well as the leaves on the third lower part of the stem were removed, Cut stems of different species were precooled by placing in cold water for 15 min. followed by recut the stems end under running water to prevent air bubbles getting into the cut end of the stem resulting plugging the conducting cells. The stems were termed to uniform at length; 60 cm for solidago spikes. The following treatments were carried out:

1. Distilled water, which was used as control.
2. 300 ppm 8-HQS.
3. 300 ppm 8-HQS + 40 gm/l sucrose.
4. 150 ppm8-HQS.
5. 150 ppm 8-HQS + 20 gm/l sucrose.
6. 0.4 mM STS for 6 h.
7. 0.4 mM STS for 6 h. + 50 gm/l sucrose.
8. 150 ppm Citric acid.
9. 150 ppm Citric acid + 20 gm/l sucrose.
10. 200 ppm Aluminum sulphate.
11. 50 ppm GA_3 for 24 h. then placed in 200 ppm $Al_2(SO_4)_3$
12. 50 ppm BA for 24 h. then placed in 200 ppm $Al_2(SO_4)_3$
13. 50 ppm GA_3 for 24 h. then placed in 200 ppm 8-HQS
14. 50 ppm BA for 24 h. then placed in 200 ppm.

Data Recorded:

- **Vase life (days).**
- **Maximum increase in fresh weight percentage :**

Fresh weight of solidago cut flowers was measured daily during vase life. The original fresh weight was measured immediately after cutting the flowers and before the immersing in keeping solutions. The flowers were weighed every 2 days until the end of the vase life. The fresh weight of each cut flowers was expressed relatively to their initial weights to represent the percentage of weight loss for each cut flower stem.[10]

Water balance:

During the shelf life period, the rate of water balance = the rate of water uptake- the rate of water loss.

- **Chemical analysis:**

a. Photosynthetic pigments

Chlorophyll *a* and *b* as well as carotenoids contents were determined in fresh leaf sample as mg/g fresh weight according to[11].

b. Total reducing and non-reducing sugars:

Fresh samples (5 gm) were homogenized with ethyl alcohol (95% v/v). A known volume (1ml) of the reducing sugars by 80% ethyl alcohol and total sugars was hrolyzed by IN sulphoric acid and pipette into colorimetric tube. An aqueous solution flowed by addition of conc.H_2SO_4 (5ml) from fast-delivering pipe and measurements of color intensity was carried out by using spectrophotometer at 490 nm wave length, according to[12].

The non-reducing sugars were calculated by the difference between the total and reducing sugars.

Statistical analysis:

The obtained data were analyzed as a complete randomized design using the analysis of variance method [13]. Means of all characters were compared by LSD test at 0.05 level of significance.

Results and Discussion

1. Effect of preservative solution on keeping quality of Solidago cut spikes

1.1. Effect of chemical preservative solution treatments on vase life (days) of Solidago cut spikes:

Data in Table (1) showed that using preservative vase solutions significantly prolonged the vase life of solidago cut spikes as compared with control treatment, in both seasons. The results showed that the best treatment was 0.4Mm STS for 6 hours, which gave (24 and 22 days) in 1st and 2nd season, respectively .The addition of 50 g/l sucrose to 0.4 mM STS for 6 hours gave (19 and 17 days) and 150 ppm 8-HQS gave (18 and 17days) in 1st and 2nd season, respectively compared with the control (18 and 16 days). These results agreed with those obtained by[14], who investigated the adverse effects of ethylene on a wide range of plant species, stated that STS can at least double the vase life of cut flowers. Similar results were obtained on Gladiolus cut flowers[15], *Dianthus caryophyllus*[4], Alstromeria cut flowers[16] who reported that BA increased vase life up to 14 days compared to control. On "Cherry Brandy" roses[17] that $Al_2(SO_4)_3$ increased vase life and improved postharvest visual quality.

Table 1. Effect of the preservative solution on vase life (days) and maximum increase on fresh weight % of *Solidago canadensis* "Tara" at 2008-2009 seasons.

Treatments	Vase life (days)		Maximum increase of fresh weight%	
	First season	Second season	First season	Second season
Distilled water	18.00	16.00	5.37	10.66
300 ppm 8-HQS	14.00	14.00	10.18	3.19
300 ppm 8-HQS + 40 g/l sucrose	8.00	10.00	13.78	9.64
150 ppm 8-HQS	18.00	17.00	4.66	7.09
150 ppm 8-HQS+20 g/l sucrose	14.00	12.00	16.06	11.00
0.4 mM STS for 6 h.	24.00	22.00	19.85	10.90
0.4 mM STS for 6 h. + 50 g/l sucrose	19.00	17.00	5.15	13.18
150ppm Citric acid	7.00	10.00	4.41	2.79
150ppm Citric acid + 20 g/l sucrose	6.00	10.00	7.73	11.81
200ppm $Al_2(SO_4)_3$	7.00	9.00	3.36	7.21
50 ppm GA_3 for 24 h. + 200 ppm $Al_2(SO_4)_3$	19.00	20.00	9.43	12.61
50 ppm BA for 24 h. + 200 ppm $Al_2(SO_4)_3$	16.00	20.00	6.29	5.77
50 ppm GA_3 for 24 h. + 200 ppm 8-HQS	20.00	22.00	10.46	10.49
50 ppm BA for 24 h. + 200 ppm 8-HQS	19.00	20.00	13.93	5.21
L.S.D 5%:	2.037	1.928	2.208	1.248

1.2. Maximum increase of fresh weight%

Data in Table (1) cleared that the maximum increase percentage of fresh weight for most treated solidago cut spikes with different preservative solutions was higher in both seasons than control treatment. The highest significant increases values for fresh weight (19.85 and 13.18%), were recorded from using 0.4mM STS for 6 hours alone and with 50 g/l sucrose on solidago cut spikes in 1st and 2nd season, respectively. The data go on line with[18] on cut rose (*Rosa hybrida*), mentioned that Silver thiosulphate were effective on increasing the permeability of the cell membrane and keeping the peroxidative changes at a minimum, however the lowest values of this parameter (4.41 and 2.79%) were determined when solidago cut spikes held in 150 ppm citric acid preservative solution in 1st and 2ndseason, respectively.

2. Water balance of solidago cut spikes.

Data in Table (2 and 3) showed that spikes were treated with different preservative solutions recorded the highest level of water balance after 6th day by using 150 ppm 8-HQS alone or with 20 g/l sucrose, 0.4mM STS alone or with 50 g/l sucrose and 50 ppm GA_3 for 24h. then placed in 200 ppm $Al_2(SO_4)_3$ or with 200 ppm 8-HQS after 6 days during shelf life period in the 1st season compared with the control. while in the 2nd season the treatment of (150 ppm 8-HQS, 0.4 mM STS for 6h. with or without sucrose and 50 ppm BA for 24h. then placed in 200 ppm $Al_2(SO_4)_3$) gave the highest level of water balance after 4 days during shelf life period, while 50 ppm BA for 24h.then placed in 200 ppm 8-HQS gave the highest level of water balance after 6 days during shelf life period in the 1st and 2nd season.

Cut spikes turgidity is the result of the balance between the level of water uptake and water loss. Adding sucrose to STS or 8-HQS increased the flowers ability to retain its absorbing water and prolongs the vase life of most flowers; also improve the flowers quality after cutting. These results were in harmony with those found by [19] on *Asiatic lilium* "Elite" who found that STS and 8-HQS showed highly significant increase in water balance.Sucrose or its combination with biocides, improved postharvest performance in cut gerbera[20].

Table 2. Effect of different vase solutions on water balance (g/spike) of *Solidago canadensis* cv. "Tara" cut spikes during 2007/2008 season

Treatments	Solidago First season								
	Water balance (g/day/spike)								
	2	4	6	8	10	12	14	16	18
Control	0.61	-0.24	-2.03	-8.78	-0.7	-0.58	-0.55	-0.64	-6.39
300 8-HQS	0.57	-0.61	-1.07	-1.26	-2.26	-0.66	-0.59	-----	------
300 ppm 8-HQS + 40 g/l sucrose	1.56	-2.22	-1.93	-1.32	-6.00	----	-----	----	-----
150 ppm 8-HQS	1.18	0.65	0.03	-1.18	-0.36	-0.77	-0.81	-1.09	-8.07
150 ppm 8-HQS+20 g/l sucrose	0.58	0.13	0.67	-0.47	-1.24	-1.22	-1.13	----	-----
0.4 mM STS for 6 h.	1.63	0.27	0.08	-0.16	-1.46	-0.98	-0.98	-0.65	-2.88
0.4 mM STS for 6 h. + 50 g/l sucrose	0.17	0.01	0.19	-0.06	-0.16	-0.44	-0.56	-0.67	-5.86
150 ppm Citric acid	0.32	0.22	-3.99	----	----	----	----	-----	-----
150 ppm Citric acid + 20 g/l sucrose	0.71	-0.3	-3.94	-----	-----	-----	-----	----	-----
200 ppm $Al_2(SO_4)_3$	0.21	-0.74	-3.97	-----	------	------	------	-----	-----
50 ppm GA_3 for 24 h. + 200 ppm $Al_2(SO_4)_3$	0.55	0.34	0.15	-1.3	-0.26	-1.39	-0.76	-0.66	-7.69
50 ppm BA for 24 h. + 200 ppm $Al_2(SO_4)_3$	0.37	0.16	-1.29	-0.67	-1.32	-0.04	-2.38	-----	-----
50 ppm GA_3 for 24 h. + 200 ppm 8-HQS	0.63	0.33	0.11	-0.98	-0.91	-0.88	-0.84	-0.70	-2.60
50 ppm BA for 24 h. + 200 ppm 8-HQS	0.22	1.02	0.48	-0.84	-1.67	----	-----	-----	------

Table 3. Effect of different vase solutions on water balance (g/spike) of *Solidago canadensis* cv."Tara" cut spikes during 2008/2009 season

Treatments	Solidago second season Water balance (g/day/spike)								
	2	4	6	8	10	12	14	16	18
Control	0.88	-1.87	0.64	-1.64	0.31	-0.57	-0.42	-0.25	------
300 ppm8-HQS	0.32	-2.19	-0.09	-0.39	-0.96	-0.56	-1.35	----	-----
300 ppm 8-HQS + 40 g/l sucrose	-0.99	1.75	-0.36	-3.95	-0.23	----	----	-----	-----
150 ppm 8-HQS	1.49	0.82	-2.11	-1.02	0.83	-5.80	-1.22	------	------
150 ppm 8-HQS+20 g/l sucrose	0.19	-0.85	-1.25	-0.18	2.22	-0.74	-----	-----	----
0.4 mM STS for 6 h.	0.57	0.56	-1.42	-1.06	-1.53	-1.67	-1.21	-0.79	-1.08
0.4 mM STS for 6 h. + 50 g/l sucrose	1.27	0.10	-1.03	-0.74	-0.81	-0.08	----	----	-----
150 ppm Citric acid	1.01	-1.33	-1.09	1.65	-1.09	-5.34	----	-----	----
150ppm Citric acid + 20 g/l sucrose	0.95	-1.23	-0.48	0.16	-1.28	----	-----	--------	-----
200 ppm $AL_2(SO_4)_3$	2.07	-0.61	-2.82	-1.36	-----	-----	------	-----	------
50 ppm GA_3 for 24 h. + 200 ppm $AL_2(SO_4)_3$	1.21	-3.64	-1.41	-0.83	-0.40	-3.18	-1.17	-0.82	------
50 ppm BA for 24 h. + 200 ppm $AL_2(SO_4)_3$	0.43	0.16	-1.38	-0.37	-0.51	-0.90	-1.07	-1.06	-1.11
50 ppm GA_3 for 24 h. + 200 ppm 8-HQS	-0.05	1.86	-0.67	-0.64	-0.50	-0.95	-0.62	-1.22	-1.18
50 ppm BA for 24 h. + 200 ppm 8-HQS	0.47	0.31	0.09	-1.34	-0.53	-1.45	-1.05	-0.67	----

Chemical constituents:

a. The chlorophyll and carotenoids content (mg/g F.W.) in leaves of Solidago cut spikes:

Data in Table (4) revealed that leaves of solidago cut spikes treated with 300 ppm 8-HQS +40 g/l sucrose gave the maximum values of chl. a, and b and total carotenoids (1.749, 1.587 and 1.796 mg/g F.W.) in the 1st season compared with control which gave (1.071, 0.765 and 0.779 mg/g F.W.), respectively. In the second season, data revealed that using preservative solutions containing 300 ppm 8-HQS + 40 g/l sucrose , 50 ppm GA_3 for 24h. then placed in 200 ppm 8-HQS and 150 ppm 8-HQS, gave the highest values of chl. a , b and total carotenoids compared with the other treatments and control. The maximum value of chl. a, b and carotenoids were found when spikes treated with 300 ppm 8-HQS +40 g/l sucrose giving (1.390, 0.814 and 1.027 mg/g F.W.). These results were in harmony with those obtained on rose "Cherry Brandy" [17], on Carnation [20] and on Celosia [21].

Table 4. Effect of the preservative solution treatments on chlorophyll a, b and carotenoid content (mg/g F.W.) of *Solidago canadensis* "Tara" during 2007/2008 and 2008/2009 seasons

Treatments	Solidago					
	1st season			2nd season		
	Chl. a	Chl. b	Carotenoids	Chl. a	Chl. b	Carotenoids
Control	1.071	0.765	0.799	0.984	0.576	0.727
300 8-HQS	1.063	0.776	0.888	0.874	0.512	0.646
300 ppm 8-HQS + 40 g/l sucrose	1.749	1.587	1.796	1.390	0.814	1.027
150 ppm 8-HQS	1.042	0.657	0.835	1.146	0.670	0.846
150 ppm 8-HQS+20 g/l sucrose	0.532	0.431	0.438	0.796	0.466	0.558
0.4 mM STS for 6 h.	0.690	0.558	1.002	0.900	0.527	0.665
0.4 mM STS for 6 h. + 50 g/l sucrose	0.839	0.648	0.515	0.843	0.493	0.623
150 ppm Citric acid	1.015	0.639	0.804	0.592	0.346	0.437
150 ppm Citric acid + 20 g/l sucrose	0.863	0.711	0.605	0.610	0.357	0.451
200 ppm Al2(SO4)3	0.518	0.750	0.729	0.703	0.411	0.519
50 ppm GA_3 for 24 h. then placed in 200 ppm Al2(SO4)3	0.959	1.021	0.690	0.736	0.431	0.544
50 ppm BA for 24 h. then placed in 200 ppmAl2(SO4)3	1.489	1.419	1.169	0.906	0.530	0.669
50 ppm GA_3 for 24 h. then placed in 200 ppm 8-HQS	1.557	1.583	1.568	1.265	0.740	0.934
50 ppm BA for 24 h. then placed in 200 ppm 8-HQS	1.237	0.880	0.784	0.704	0.412	0.520
L.S.D 5%	**0.241**	**0.502**	**0.371**	**0.115**	**0.068**	**0.085**

b. Sugars contents (mg/g D.W):

Results presented in Table (5) showed that the highest values of total sugars in leaves of solidago cut spikes were found when treated with 50 ppm GA_3 for 24h. then placed in 200 ppm 8-HQS giving (54.21 and 50.31 mg/g D.W.), followed by 300 ppm 8-HQS + 40 g/l sucrose which gave (44.12 and 43.36 mg/g D.W.) and then 300 ppm 8-HQS by (41.73 and 36.88 mg/g D.W.) compared with control giving (26.43 and 21.66 mg/g D.W.) in the 1st and 2nd season, respectively. The same results were found in non-reducing sugars.

Table 5. Effect of the preservative solution treatments on total sugar, reducing sugar, and non-reducing sugar (mg/g D.W.) of *Solidago canadensis* "Tara" during 2007/2008 and 2008/2009 seasons

Treatments	Sugars (mg/g D.W.)					
	Total		Reducing		Non-reducing	
	First season	Second season	First season	Second season	First season	Second season
Distilled water	26.43	21.66	3.00	3.17	23.43	18.49
300 ppm 8-HQS	41.73	36.88	4.83	5.67	36.90	31.21
300 ppm 8-HQS + 40 g sucrose	44.12	43.36	1.83	2.50	42.28	40.86
150 ppm 8-HQS	32.23	29.46	4.83	5.17	27.40	24.29
150 ppm 8-HQS+20 g sucrose	20.79	18.69	3.50	3.33	17.29	15.36
0.4 mM STS for 6 h.	37.42	35.89	2.83	2.50	34.58	33.39
0.4 mM STS for 6 h. + 50 g sucrose	30.76	29.19	2.50	2.17	28.26	27.02
150 ppm Citric acid	22.67	21.75	3.17	3.50	19.51	18.25
150 ppm Citric acid + 20 g sucrose	22.44	23.13	3.50	2.83	18.94	20.29
200 ppm $Al_2(SO_4)_3$	22.09	22.05	3.50	3.83	18.59	18.21
50 ppm GA_3 for 24h. + 200 ppm $Al_2(SO_4)_3$	34.44	34.40	5.17	5.50	29.28	28.90
50 ppm BA for 24h. + 200 ppm $Al_2(SO_4)_3$	20.14	19.30	3.17	2.83	16.97	16.47
50 ppm GA_3 for 24h. + 200 ppm 8-HQS	54.21	50.31	4.17	4.50	50.04	45.81
50 ppm BA for 24h. + 200 ppm 8-HQS	15.32	15.12	6.17	5.83	9.15	9.29
L.S.D $_{5\%}$:	1.29	0.90	0.54	0.59	1.47	0.67

Concerning the reducing sugars content data reported that the highest values were found by using preservative solution contain 50 ppm BA for 24h.then placed in 200 ppm 8-HQS giving (6.17 and 5.83 mg/g D.W.) compared with control giving (3.00 and 3.17 mg/g D.w) in the 1st and 2nd season, respectively. Our results are in agreement with those obtained by[23,24] on rose cut flowers, they reported that the effect of sugars on the supply of substances for respiration and therefore the longer life of cut flowers in generally recognized in the delay of ethylene biosynthenthis. Treating cut foliage and gladiolus with BA at 2.5 ppm gave maximum values of total sugars[25,26]. BA and GA_3 resulted significant increase in reducing sugars[27].

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