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Effect of sucrose, citric acid and 8- HQS concentrations on postharvest quality attributes in cut golden rod flower (*Solidago canadensis* L.)

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Abstract
To investigate the impact of different preservatives on postharvest quality attributes in golden rod, a laboratory experiment was carried out at the Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru. The experiment focused on investigating the effects of sucrose, citric acid and 8HQS on vase life golden rod flower. The results showed that the maximum water uptake (7.53 g/cut flower) was observed with T_2 (Sucrose 2%+200 ppm 8HQS), which was significantly higher than all other treatments, while the lowest water uptake (6.00 g/cut flower) was observed in the control group (T_9). T_2 (Sucrose 2%+200 ppm 8HQS) also resulted in the highest fresh weight (12.20 g/cut flower), followed by T_3 (Sucrose 2%+200 ppm citric acid), while the lowest fresh weight (8.03 g/cut flower) was recorded in the control group (T_9). In terms of vase life, the cut golden rod flowers treated with T_2 (Sucrose 2%+200 ppm 8HQS) had the longest vase life (10.33 days), whereas the control group had the shortest vase life (7.00 days).

Keywords: 8HQS, citric acid, sucrose, vase life and golden rod

1. Introduction

Golden rod (*Solidago canadensis* L.), is a popular flower crop grown for its cut flowers worldwide. There is a constant and growing demand for golden rod cut flowers in both domestic and international markets. Several techniques exist to maintain the quality of cut flowers after harvesting, including pulsing, proper packaging, storing at an optimal temperature, and using an appropriate holding solution. Typically, a vase solution comprises water to preserve turgidity, a pH-lowering chemical, sugar as an energy source, a germicide to inhibit microorganism growth, and an anti-ethylene or anti-senescence agent.

Maintaining the quality of cut flowers is a crucial factor that consumers consider when purchasing flowers. Chemical preservatives have been demonstrated to prolong the lifespan of cut flowers. Thus, increasing the vase life of flowers by employing chemical preservatives would assist consumers in maintaining their flowers in vases for an extended period. Against this backdrop, the aim of this investigation was to evaluate how biocide (8-HQS), sucrose and citric acid at different concentrations affect the vase life of cut golden rod.

The primary aim of the current research was to investigate how the combination of sucrose solution, citric acid, and 8HQS (8-hydroxyquinoline sulfate) affected the post-harvest longevity and preservation of quality in cut flowers of Golden rod.

2. Materials and Methods

The flowers were harvested when $1/3^{rd}$ of top inflorescence are opened with uniform stalk length (40 cm) and were kept in bucket containing water and brought to the laboratory then spikes were placed in beaker (500 ml capacity) with 250 ml solution in each beaker kept in lab condition (Average temperature 24 °C, Relative Humidity 60%) The experiment was conducted in completely randomized design with 9 treatments *viz.*, T_1 – Sucrose 2%+100 ppm 8HQS T_2: Sucrose 2% + 200 ppm 8HQS, T_3: Sucrose 2%+200 ppm citric acid T_4: Sucrose 2%+300 ppm citric acid T_5 : Sucrose 2%+100 ppm 8HQS+200 ppm citric acid, T_6 - Sucrose 2%+100 ppm 8HQS+ 300 ppm Citric acid, T_7 - Sucrose 2%+200 ppm 8HQS+200 ppm Citric acid, T_8: Sucrose 2%+200 ppm 8HQS+300 ppm Citric acid T_9: Control (water), were replicated thrice. Data pertaining to water uptake (g), fresh weight of the flowers (g), and vase life (days) was recorded.

Data was recorded on uptake of water (g), fresh weight of flowers (g) and vase life (days).

Fig 1: Pictorial view of the effect of different chemical treatments on golden rod

3. Results and Discussion

The results on water relations viz., uptake of water, fresh weight and vase life pertaining to golden rod cut flowers as influenced by pulsing solution are presented below.

3.1 Uptake of water

Table 1 displays the data regarding the water uptake by golden rod cut flowers in relation to the pulsing solution. When comparing treatments for water uptake on the 2nd, 4th, 6th, 8th and 10th day of vase life, significant differences were found. When compared to all other treatments, the T_2 treatment showed the highest water uptake (7.53), whereas, the T_5 treatment showed the lowest value (5.4) on the 10th day.

Cut flowers continue to transpire and respire even after harvest. Water helps transport energy sources to different regions of the flower and keeps cut flowers in a turgid state. More importantly, the water relations of a cut flower are assessed in terms of its intake, loss and balance. The freshness of cut flowers is determined by the water interactions.

The highest solution volume consumption was observed in the combination of sucrose and 8-HQS in the case of Gladiolus Cv. American Beauty, as reported by Sashikala and Ranbir in 2001. This increase in solution consumption can be attributed to the positive impact of 8-HQS, which enhances water uptake due to its antimicrobial properties. In an earlier study by Van Doorn in 1997, it was found that antimicrobial treatments resulted in a reduction of bacterial presence around the cut surface and within the xylem of golden rod stalks. This reduction in bacterial growth contributed to a decrease in stem blockage, as highlighted by Ketsa and Treetaruyanodha in 1998 [8], ultimately leading to an improved water uptake.

Table 1: Effect of sucrose, citric acid, and 8-HQS concentrations on the water uptake in a cut golden rod flower.

Treatments	Uptake of water (g/cut flower)				
	2nd day	**4th day**	**6th day**	**8th day**	**10th day**
T_1	7.97	7.27	6.90	6.63	6.30
T_2	8.43	8.10	8.00	7.80	7.53
T_3	8.23	7.90	7.70	7.56	7.20
T_4	7.33	6.97	6.60	6.40	6.13
T_5	7.10	6.37	6.10	5.73	5.40
T_6	7.63	7.23	7.10	6.80	6.57
T_7	7.16	6.73	6.50	6.37	6.10
T_8	7.03	6.87	6.40	6.10	5.80
T_9	6.36	6.10	6.10	6.23	6.00
C.D. (5%)	1.28	0.41	0.27	0.34	0.23

3.2 Fresh weight

The data in Table 2 presents the impact of different pulsing solutions on the fresh weight of golden rod cut flowers. Significant variations were observed among the treatments in relation to the fresh weight of these flowers throughout their vase life. The highest fresh weight was obtained by treatment T_2 (12.2) whereas, the treatment T_9 (8.03) control shows lowest fresh weight on 10th day compared to all other treatments. This could be due to the synergistic interaction of sucrose and 8-HQS. Sucrose provides essential nutrients for metabolic processes, while 8-HQS plays a critical role maintaining cell structure, function, integrity and possessing antimicrobial properties that leads to preventing stem blockage. These results are in accordance with the previous studies conducted by Hassan *et al*. (2003) [6] reported that 8-HQS's ability to enhance water absorption, ultimately resulting in an extended vase life. Banaee *et al*. (2013) [3] observed that 8-hydroxyquinoline sulfate and sucrose increased longevity and anthocyanin content of cut gerbera flowers. Abdel-Kader *et al*. (2017) [1] examined the impact of 8-hydroxyquinoline sulfate, silver nitrate, silver nano particles and chitosan on vase life and quality of cut rose flowers (Rosa hybrida. cv. "Black magic").

Table 2: Effect of sucrose, citric acid and 8- HQS concentrations on fresh weight and vase life of cut golden rod flower

Treatments	Fresh weight (g/cut flower))					Vase life
	2nd day	**4th day**	**6th day**	**8th day**	**10th day**	**Days**
T_1	9.90	10.00	10.37	10.50	10.80	8.66
T_2	11.50	11.60	11.80	11.90	12.20	10.33
T_3	11.06	11.17	11.33	11.57	11.70	10.00
T_4	10.50	10.73	10.93	11.23	11.30	7.66
T_5	10.10	10.40	10.67	10.80	11.06	8.66
T_6	9.83	10.03	10.33	10.80	11.06	7.66
T_7	10.37	10.73	10.90	11.33	11.56	9.00
T_8	9.83	10.10	10.30	10.57	10.76	7.66
T_9	7.70	7.90	7.53	7.87	8.03	7.00
C.D 5%	0.26	0.28	0.31	0.34	0.29	1.28

3.3 Vase life

The data on vase life of golden rod cut flowers held in pulsing solutions are presented in Table 2. Significant differences were obtained between treatments. Treatments T_2 and T_3 which were on par with each other exhibited longer (10.33 and 10.00 days, respectively) vase life, while treatment T_1, T_6 and T_8 and T_9 which were on par with each other recorded the shortest (7.66, 7.66, 7.66, and 7.00 days, respectively) vase life.

The 8-HQS treatment increased the vase life with increasing concentration. The most effective treatment was found to be the combination of 300 ppm 8-HQS and 2% sucrose, which gave a vase life of 10.33 days, compared to days for the other treatments. The results show the importance of 8-HQS in increasing the vase life of cut golden rod. This could be because 8-HQS (8-Hydroxyquinoline sulphate) functions as a bactericide and pH regulator, lowering the pH of water and enhancing water intake and hydration of the flowers, which prolongs vase life. Sucrose serves as a carbohydrate and is necessary for the metabolism of cut flowers.

These outcomes are in agreement with the findings of Hussein (1994) [7] on cut flowers of chrysanthemum and calendula. Knee (2000) [9] also discovered that that using HQS extended the vase life of cut carnation flowers and prevented microbes from clogging xylem components. This could be attributed to the role of 8-HQS in increasing the level of absorbance, as the result of which, the vase life was increased (Hassan *et al*., 2003) [6]. Elgimabi and Ahmed (2009) [5] studied on rose cut flowers, Asrar (2012) [2] studied on vase life and keeping quality of snapdragon. Chang and Chang (2013) [4] on vase life of *Eustoma grandiflorum*.

4. Conclusions

The post-harvest quality of cut golden rods was improved with the use of chemicals, and the results indicate that a higher concentration (200 ppm) of 8HQS was particularly effective, possibly due to its antimicrobial properties that can reduce stem plugging. The maintenance of leaf turgidity and the prevention of significant weight loss may also contribute to the positive outcome.

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