Postharvest features of chrysanthemum cut flowers as affected by different chemicals

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Summary: Cut flowers of *Chrysanthemum morifolium* RAM cv. Suny Reagan were treated with different concentrations of 8-hydroxyquinoline sulfate (8-HQS), silver thiosulfate (STS) and 1-methylcyclopropene (1-MCP) in order to improve the post production quality. 8-HQS was used at 200 and 400 ppm with or without sucrose at 50 g/l. STS was used at 0.2, and 0.4 mM with or without sucrose at 50 g/l 1-MCP was used at 0.3, 0.5 and 0.7 g/m^3 for 6h.

All the treatments of 8-HQS prolonged the vase life and minimized the percentage of weight loss of chrysanthemum cut flowers compared to the control. The vase life was larger when sucrose not combined with 8-HQS. The best treatment of 8-HQS was 400 ppm 8-HQS without sucrose. STS treatment led to prolong the vase life and minimized the percentage of weight loss comparing to the control. In addition, the effect was better when sucroseas was added to STS. The treatment of STS at 0.4 mM + 50 g/l sucrose was the best one. 1-MCP treatment increased the vase life and lowered the percentage of weight loss at any level comparing with untreated control. The best treatment in this concern was 1-MCP at 0.5 g/m^3 for 6h. The chlorophyll content (chl.a and chl.b) of the leaves for the best treatment of each chemical was higher than that of the control. The treatment of 1-MCP at 0.5 g/m^3 6h gave the best results in this respect.

Key words: Chlorophyll, vase life, 1-MCP, cut flowers, STS, 8-HQS.

Introduction

Wilting is the most common reason for the termination of the useful vase life of many cut flowers. Cut chrysanthemum flowers have a longer vase life than the most other cut flowers.

The loss of Quality is mainly due to their leaves wilting because of impeded water transport (Van Doorn 1999). Blockage of xylem vessels by microorganisms that accumulate in the vase solution or in the vessels themselves is the major cause of deterioration in cut flowers (Knee 2000).

In order to control microorganism growth to prevent the block of xylem, the chemicals most commonly used are salts of 8-HQ (*Nowak & Rudnicki*, 1990). Holding cut chrysanthemum flowers continuously in 100ppm of 8-HQS resulted in the longest vase life and the treatment was effective in controlling bacterial growth (*Hussein*, 1994). Cut chrysanthemum flowers kept in a solution containing 8-HQS had the longest vase life as well as the lowest fresh weight loss (*Anju* et al., 1999). Silver thiosulphate is one of the most common forms of silver salts used in commercial flower preservative solutions. This chemical extended the vase life of different cut flowers. *Menguc & Usta* (1994) stated that STS + sucrose pretreatment had a positive effect on the vase life and petiole size of carnation cut flowers. There is an increasing trend in the fresh weight and vase life of rose cut flowers when STS was used (Chikkasubbanna & Yogitha 2002, *Tiwari* et al., 2002). Cut flowers produce small amounts of ethylene just after harvest. Meanwhile, there is sharp increase in ethylene production few days after harvest. Although chrysanthemum flowers produce small amounts of ethylene and undergo accelerated senescence in response to this hormone (*Bartoli* et al., 1997). Some deleterious effects of ethylene exposure include leaf yellowing, flower (or petal) drop, irregular opening and premature death (*Nowak & Rudnicki*, 1990).

Since the 1970s, the best compound against ethylene has been silver thiosulfate (STS) which can at least double the vase life of cut flowers (*Reid* et al., 1999). A new tool, 1-methylcyclopropene (1-MCP), has been added to the list of options for extending the vase life of cut flowers. *Cross* (1996) reported that 1-MCP was an effective and safe alternative to STS. *Sisler & Serek* (2001) reported that 0.5 nl/l of 1-methylcyclopropene (1-MCP) was sufficient to protect carnation flowers for several days against ethylene and extended the vase life of carnation cut flowers. Also, *Hassan & Gerzson* (2002) reported that the treatment of 1-MCP at 0.5 g/m^3 for 6h led to increase the vase life as well as minimize the% loss of initial weight of chrysanthemum and carnation cut flowers.

Research work for improving quality and prolonging the vase life of cut chrysanthemum flowers must be taken in consideration. The aim of this research is to study the postharvest features of chrysanthemum cut flowers as affected by 8-HQS (8-hydroxyquinoline sulfate), STS (silver thiosulfate) and 1-MCP (1-methylcyclopropene).

Material and method

Plant material

Cut flowers used in the experiment were *Chrysanthemum morifolium* RAM cv. Suny Reagan. The flowers were obtained from a commercial grower in Hungary at commercial maturity. Flowers were brought to the laboratory of BKÁE, Budapest after harvest. Lower leaves were removed and the flowering stems were trimmed to a uniform length of 50 cm.

Chemical treatments

8-hydroxyquinoline sulfate (8-HQS) was applied as a continuous treatment at concentrations of 200 and 400 ppm with or without sucrose of 50 g/l. The flowers were placed in glass vials containing 500 ml 8-HQS solution of each concentration during the whole period of the experiment.

Silver thiosulfate was prepared as described by *Gorin* et al., (1985). Cut flowers were treated with STS for 6h at concentrations of 0.2 and 0.4 mM with or without sucrose at 50 g/l. After pulsing treatments the flowers were placed in glasses containing tap water till the end of experiment.

1-MCP (as EthylBloc) was obtained from AgroFresh Inc. Rohm & Haas company. The flowers which were treated with EthylBloc were lied inside a 118×28×44cm box for each treatment. The boxes were sealed well with plastic cover and the concentrations of 1-MCP were calculated as g/m^3 (EthylBloc per cubic meters). Soon, the EthylBloc powder was weighed and placed in a test tube taped to the inner wall of the box. Since a significant percentage of 1-MCP is released immediately after addition of hot water, the box was first sealed, and then, hot water was injected into the test tube (just enough to cover the powder for each treatment). The concentrations, which used were 0.3, 0.5 and 0.7 g/m^3 for 6h. The treatment of 1-MCP was conducted at 15 °C for all treatments.

The control flowers were put into glasses containing 500 ml tap water during the whole period of the experiment.

Vase life determination

Wilting of leaves as well as flowers was used as the criterion for the termination of the vase life of chrysanthemum flowers. Visual rating of leaves and flowers senescence were evaluated periodically during the vase life of flowers. Evaluation was based on a scale ranging from 1 to 4 when: 1 = entirely green leaves and good flowers, 2 = initiation of wilting in 25%, 3 = wilting in 25–50%, 4 = wilting in 50–100% of leaves as well as flowers. The longevity of chrysanthemum cut flowers was defined as the number of days in vase life required for 50% of the flowers to reach stage 2 or advanced stages.

Fresh weight measurements

Fresh weight determinations of the flowers were made just before the immersion of the flowers into the glasses of solutions and were repeated on the day when the vase life of the control flowers was terminated. The flowers were taken out of solutions for as a short time as possible (20–30s). The fresh weight of each flower was expressed relative to the initial weight to represent the% of weight losses.

Chlorophyll determination

Chlorophyll content of leaves was extracted by acetone as previously described by (Dawood 1993) from samples of cut leave segments (0.5 g) taken on day 6 and on the day when the vase life of the control flowers was terminated. The samples were taken from the upper part of stems. The chlorophyll content was calculated as mg/g fresh weight.

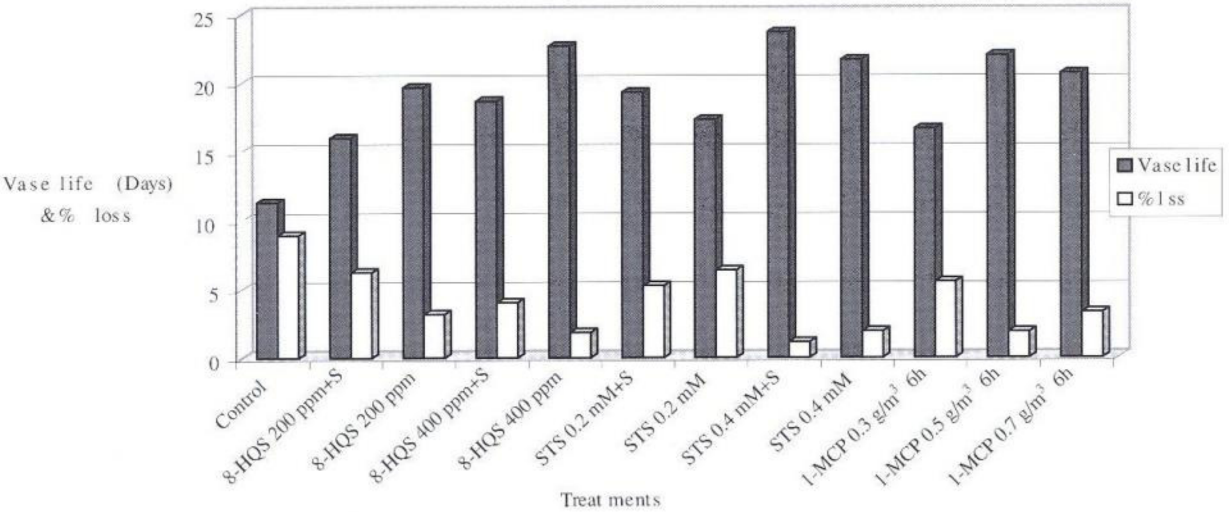

Figure 1 Effect of 8-HQS, STS and 1-MCP on the vase life and % loss of initial weight of chrysanthemum cut flowers

Analysis of results

Three replications of five flowers each were used per treatment in this experiment. Results were analyzed by using SPSS program Base 9, SPSS Inc., USA. The analysis of variance (ANOVA) as well as differences between means was performed by using Student-Newman-Keuls test (SNK) at 0.05 level.

Results

Vase life

The results *(Table 1)* show that the treatments of 8-HQS prolonged the vase life of chrysanthemum cut flowers compared to the control. The vase life was increased gradually with increasing the concentration of 8-HQS. Otherwise, adding sucrose to all concentrations of 8-HQS gave lower vase life than the treatments of 8-HQS without sucrose. The best treatment was 400 ppm 8-HQS without sucrose, which gave 22.67 days compared to 11.33 days for the control *(Figure 1)*.

Using STS treatment comparing to the untreated control significantly increased the vase life of chrysanthemum cut flowers. Adding sucrose to the concentrations of STS gave longer vase life than the treatments without sucrose. The best treatment was STS at 0.4 mM + 50 g/l sucrose, which recorded 23.67 days comparing to 11.33 days for the control (*Table 1* and *Figure 1*).

All levels of 1-MCP prolonged the vase life of chrysanthemum cut flowers. The best treatment in this respect was 1-MCP at 0.5 g/m^3 for 6h (*Table 1* and *Figure 1*) which gave 22 days comparing to the control which gave 11.33 days.

Percentage of weight loss

The results in Table 1 show that 8-HQS treatment influenced the % of weight loss of chrysanthemum cut flowers. All the treatments significantly minimized the % of weight loss comparing with the control. Adding sucrose to all levels of 8-HQS had a negative effect in this respect. The minimum % of weight loss was obtained by 400 ppm 8-HQS (*Table 1* and *Figure 1*).

All STS treatments lowered the % of weight loss than the untreated control. In addition, combining sugar with STS treatment gave lower values than STS treatment without sugar. The lowest % of weight loss was obtained by 0.4 mM STS + 50 g/l sucrose, which recorded 1.16% comparing with 8.92% of the control (*Table 1* and *Figure 1*).

1-MCP treatments minimized the % of weight loss. The lowest value in this respect (1.9%) was obtained by the treatment of 1-MCP at 0.5 g/m^{-3} for 6h comparing to the control which resulted in the maximum percentage (8.92%) of weight loss (*Table 1* and *Figure 1*).

Table 1 Effect of 8-HQS, STS and 1-MCP on the vase life and % loss of initial weight of chrysanthemum cut flowers

Treatments	Vase life (Days)	% loss of initial
Control	11.33 a	8.92 a
8-HQS 200 ppm+50 g/l sucrose	16.00 b	6.25 b
8-HQS 200 ppm	19.67 de	3.18 de
8-HQS 400 ppm+50 g/l sucrose	18.67 d	4.02 cd
8-HQS 400 ppm	22.67 gh	1.85 ef
STS 0.2 mM+50 g/l sucrose	19.33 d	5.26 bc
STS 0.2 mM	17.33 c	6.39 b
STS 0.4 mM+50 g/l sucrose	23.67 h	1.16 f
STS 0.4 mM	21.67 fg	1.92 ef
1-MCP 0.3 g/m^3 6h	16.67 bc	5.53 bc
1-MCP 0.5 g/m^3 6h	22.00 g	1.90 ef
1-MCP 0.7 g/m^3 6h	20.67 ef	3.32 de

Means followed by different letters are significantly different according to SNK test at $P = 0.05$.

Chlorophyll content

A significant delay in chlorophyll loss (chl.a and chl. b) was monitored as a result of using different chemical treatments. All chemical treatments minimized the chlorophyll loss comparing with untreated control. The best treatment in this concern was 1-MCP 0.5 g/m^3 6h. Under this treatment the chlorophyll content of the leaves at the end of control was 2.11 and 0.66 mg/g comparing to 0.72 and 0.30 mg/g for the control for chlorophyll a and chlorophyll b, respectively (*Table 2* and *Fig. 2*)

Table 2 Effect of the best treatment of each chemical on the chlorophyll content (mg/g fresh weight) of leaves of chrysanthemum cut flowers

Treatments	Day 6		End of control	
	chl.a	chl.b	chl.a	chl.b
Control	1.31 a	0.56 a	0.72 a	0.30 a
8-HQS 400 ppm+50 g/l sucrose	1.98 b	0.62 b	1.23 b	0.51 b
STS 0.4 mM+50 g/l sucrose	2.58 c	1.04 c	2.13 c	0.86 c
1-MCP 0.5 g/m^3 6h.	2.86 d	1.33 d	2.11 c	0.66 d

* Means followed by different letters are significantly different according to SNK test at P = 0.05.

* Results were analyzed separately for each sampling day and statistical analysis is valid only within one column.

Discussion

The results obtained show the importance of 8-HQS in extending the vase life of chrysanthemum cut flowers. These results may be due to the role of 8-HQS as anti-microbial agent and hence, reduce stem plugging. These results are in agreement with the finding of *Hussein* (1994) on chrysanthemum and calendula cut flowers. Also, *Knee* (2000) mentioned that the blockage of xylem elements by microorganisms was prevented by using HQC and the vase life of carnation cut flowers was increased. Also, under the 8-HQS treatment the percentage of weight loss and chlorophyll degradation was minimized and consequently, the vase life was extended.

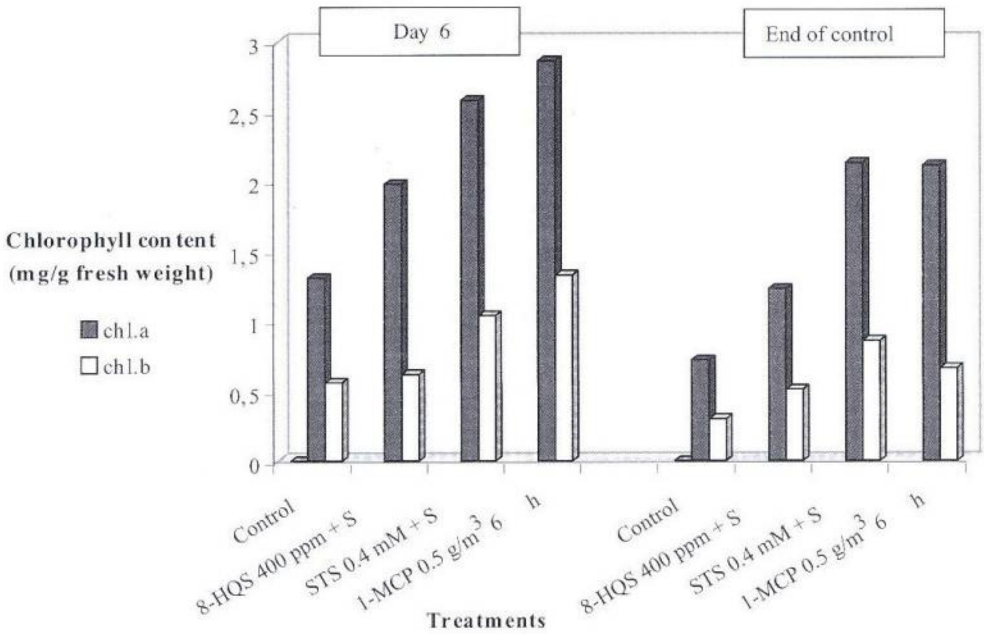

Figure 1 Effect of 8-HQS, STS and 1-MCP on the vase life and % loss of initial weight of chrysanthemum cut flowers

Silver thiosulfate (STS) is a very potent inhibitor of ethylene action in plant tissues. It also provides some antimicrobial activity inside the plant tissues. These results are confirmed with the results of *Menguc & Usta* (1994) on carnation cut flowers. Also, Hassan & Schmidt (2003) found similar results in this respect on chrysanthemum cut flowers. In addition, keeping the leaves in a good state by lowering the percent of weight loss and retarding the chlorophyll degradation may be led to increase the vase life.

Extending the vase life of chrysanthemum cut flowers by using 1-MCP could be attributed to the role of 1-MCP as an inhibitor of ethylene biosynthesis as well as ethylene binding and consequently preventing the undesirable postharvest effects of ethylene as reported by *Serek* et al., (1995). Similar results were obtained by *Sisler & Serek* (2001) who reported that 0.5 nl/L of 1-methylcyclopropene (1-MCP) is sufficient to protect carnation flowers for several days against ethylene and extended the vase life of carnation cut flowers. Also, the treatment of 1-MCP at 0.5 g/m^3 for 6h led to an increase in the vase life as well as minimize the % loss of initial weight of chrysanthemum and carnation cut flowers (*Hassan & Gerzson* 2002, *Hassan* et al., 2003, *Hassan & Schmidt,* 2003). In addition, these results could be explained through maintaining the leaves turgid, by keeping fresh weight and chlorophyll losses to a minimum by the treatment of 1-MCP.

1-MCP treatment does not have the heavy metal implications of STS treatment, and there should be no waste disposal problem. Since the material is a gas its use would obviate the need for placing flowers in additional treatment solutions, which is labor intensive. (*Serek* et al., 1995).

It could be concluded that 1-MCP is an effective blocker of ethylene perception in the chrysanthemum cut flowers. Furthermore, its non-toxic character makes the material an excellent substitute for the environmentally unsafe silver ion.

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