Bot. Bull. Acad. Sin. (2000) **41:** 299-303

Postharvest life of cut rose flowers as affected by silver thiosulfate and sucrose

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(Received October 22, 1999; Accepted February 23, 2000)

Abstract. A pulse treatment of sucrose at 0, 20, 40, 60, 80, 100, and 120 g L^{-1} in combination with 8-hydroxyquinoline sulfate (HQS) at 200 mg L^{-1} for 10 h was evaluated daily for its effect on the vase life and flower quality of cut rose flowers. The pulse treatment of sucrose at above 80 g L^{-1} produced a vase life of 6 to 7 days, while at below 80 g L^{-1} vase life was maintained for 4 days on average. The pulse treatment of silver thiosulfate (STS) at 0.2 mM for 2 h or STS for 2 h followed by sucrose at 120 g L^{-1} supplemented with HQS for 10 h extended the vase life of cut rose flowers to about 9 and 10 days, individually. On the other hand, a pulse treatment with sucrose or distilled water in combination with HQS maintained vase life for 7 and 3 days, respectively. Flower quality of specimens treated with STS followed by sucrose in combination with HQS was better than that of those treated with STS alone. Although visual quality could be maintained for up to 13 days in STS followed by sucrose in combination with HQS, flower quality decreased notably after 10 days. The ethylene production was greatest in untreated rose flowers (about 3 h after harvest) and decreased after chemical solutions treatment. The inhibition of ethylene production was greater in sucrose in combination with HQS than with STS or STS followed by sucrose along with HQS, although the effectiveness of the latter for maintaining rose vase life was better than the former.

Keywords: Cut flower; Ethylene production; *Rosa hybrida*; Silver thiosulfate; Sucrose; Vase life.

Introduction

The rose is a major ornamental plant in Taiwan. Kaohsiung is an important production area with high yields. Commercially, rose flowers are marked either as potted plants or cut flowers. The prevalent method for maintaining the vase life of cut flowers is the use of moderately low temperatures. An alternative is the use of a sucrose solution (Chin and Sacalis, 1977; De Stigter, 1981; Dimalla and Van Staden, 1980; Durkin, 1979; Ichimura and Hiraya, 1999; Larsen and Scholes, 1966; Mayak et al., 1974; Sacalis and Chin, 1976; Van Doorn et al., 1991; Zieslin et al., 1978). Such a solution can affect vase life, ethylene production, and regulation of sugar accumulation in floral organs (Ichimura and Hisamatsu, 1999; Ishihara et al., 1991; Kaltaler and Steponkus, 1976; Stead and Moore, 1983).

Ichimura and Hiraya (1999) and Sexton et al. (1995) indicated that a pulse treatment of sucrose and/or silver thiosulfate (STS) was effective in maintaining the vase life of cut sweet pea flowers. Meir et al. (1995) reported that mini-gladiolus cut spikes, together with sucrose plus STS pulsing, offered potential advantages of extending their vase life and maintaining flower quality. Moreover, Han (1998) also reported that the postharvest quality of cut *Heuchera sanguinea* was significantly improved and its vase life significantly increased by pulsing the inflorescence with STS for 4 h followed by placing the stems in a sucrose solution containing cntdotL-1 8-hydroxyquinoline citrate. However, relatively few studies have reported on the effects of the pulse treatment of sucrose and/or STS on improving the vase life of cut rose flowers.

The objective of our study was to determine the effects of STS pulse treatments followed by sucrose on vase life, flower quality and ethylene production in cut rose flowers.

Materials and Methods

The cut flowers in these experiments were "*Rosa hybrida* L. cv. Diana," grown in Kaohsiung County, Taiwan and used about 3 h after harvesting.

Pulse Treatment of Sucrose and STS to Vase Water

Half-open flowers were cut from the plants, and recut to 35 cm in length. Eight treatments were tested: cut flowers were kept in a 1000 mL-vessel containing 800 mL solution containing 0, 20, 40, 60, 80, 100, and 120 g L^{-1}

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sucrose supplemented with 200 mg L^{-1} HQS. The pulse treatment of each solution was kept for 10 h, and then transferred to distilled water. In addition, a pulse treatment of STS at 0.2 mM for 2 h, and STS for 2 h followed by sucrose at 120 g L^{-1} in combination with HQS at 200 mg L^{-1} for 10 h was conducted. For comparison, a 10-h pulse treatment of water control and sucrose, both containing HQS at 200 mg L^{-1}, was constructed. The cut flowers were maintained at 23°C under a 12-h photoperiod with 15 $\mu mol \cdot M^{-2} \cdot s^{-1}$ irradiance with cool-white fluorescent light. Flower diameters were measured daily. Maximum flower diameter was recorded. The vase life of flowers was defined as the time from harvest to the time that flowers wilted or their stems became bent.

Determination of Ethylene Production

The flowers were detached daily after treatment. The individual flower was sealed in a 100 mL Erlenmeyer flask and kept at 23°C. After 2 h, a 1 µL gas sample was injected into a GC equipped with a sodium chloride modified Alumina Fl 60-80 column and a flame ionization detector. Standard of 1 ppm ethylene at 1 µL was used for calibration. The peak area was calculated with an integrator.

Results and Discussion

HQS is a well known germicide that has little effect in extending the vase life of cut flowers (De Stigter, 1981; Ichimura and Hisamatsu, 1999; Jones and Hill, 1993; Larsen and Scholes, 1966; Van Doorn et al., 1990). In our study, after a pulse treatment with HQS solution alone, the cut rose flowers did not fully open and/or opened but wilted 3 more d after treatment. Ichimura et al. (1998) also indicated that HQS alone has little effect on the vase life or climacteric ethylene production of cut flowers. Therefore, the effect of HQS on ethylene production was

Table 1. Effects of sucrose pulse treatment at different concentrations on longevity of cut rose flowers. All solutions contained 200 mg L^{-1} HQS, and pulse treatments were conducted for 10 h. Values are means of 3 replications ± standard errors.

Concentration (g L^{-1})	Flower longevity (days)
0	3.3 ± 0.7
20	4.2 ± 0.5
40	5.1 ± 0.6
60	5.8 ± 0.5
80	6.2 ± 0.9
100	6.7 ± 0.3
120	7.4 ± 0.8

Table 2. Longevity of cut rose flower as influenced by pulse treatment of sucrose, STS (0.2 mM) or STS followed by sucrose. Treatment times for STS were 2 h, and 10 h for sucrose. Sucrose concentration was kept at 120 g L^{-1} in combination with 200 mg L^{-1} HQS. Values are means of 3 replications ± standard errors.

Treatment	Flower longevity (days)
Water control (+HQS)	3.4 ± 0.3
Sucrose (+HQS)	8.2 ± 0.5
STS	9.1 ± 0.2
STS + sucrose (+HQS)	10.2 ± 0.3

Table 3. Flower diameter as affected by a pulse treatment of sucrose, STS or STS followed by sucrose. Sucrose concentration was kept at 120 g L^{-1} in combination with 200 mg L^{-1} HQS. Values are means of 3 replications ± standard errors.

Treatment	Flower diameter (cm)
Water control (+HQS)	3.1 ± 0.2
Sucrose (+HQS)	3.5 ± 0.3
STS	3.8 ± 0.2
STS + sucrose (+HQS)	4.5 ± 0.3

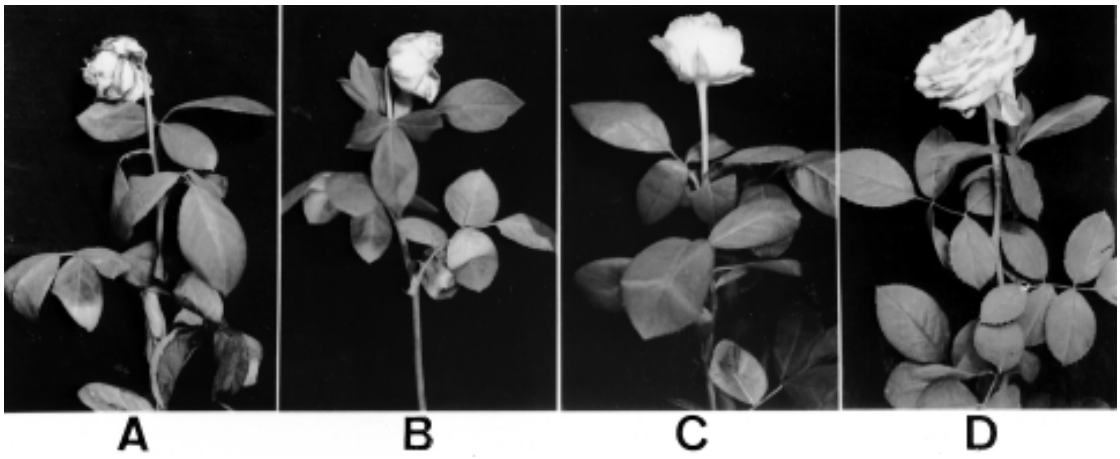

Figure 1. Flower longevity of cut roses as affected by a pulse treatment of sucrose, STS, and STS followed by sucrose. Water controls or sucrose (120 g L^{-1}) contained 200 mg L^{-1} HQS. A, water; B, sucrose; C, STS; D, STS + sucrose. Photographs were taken 8 d after treatment.

ignored, and the vase life of the rose cut flowers was attributed to sucrose and STS.

Ichimura and Hiraya (1999) reported that the pulse treatment with 100 g L^{-1} sucrose in combination with 200 mg L^{-1} HQS for 16 h had a significant effect on extending the vase life of cut sweet pea flowers. Mor et al. (1984) also indicated that a pulse treatment with STS or STS with 4% sucrose was markedly effective in extending the vase life of the same species. We found that a pulse treatment of sucrose at 120 g L^{-1} for 10 h had higher vase life and flower quality in cut rose flowers (Table 1). However, sucrose concentrations over 120 g L^{-1} in the pulse treatment had little positive effect on vase life or flower quality in roses (data not shown). In addition, flowers with sucrose concentration at 120 g L^{-1} opened later or wilted earlier as compared with the plants placed in STS or STS followed by sucrose (Figure 1). These results indicate that a pulse treatment with an optimal sucrose solution has a pronounced effect on vase life and flower quality in cut rose flowers. Kaltaler and Steponkus (1976) reported that exogenous sugars may somehow be maintaining the structural integrity of the cell membranes of rose flowers. Therefore, leakage of these substrates is prevented and/or reduced by sugar treatment. Aarts (1957) also suggested that exogenous sucrose in some way maintains the structure and semi-permeability of the plasma membrane. Furthermore, treatment of cut flowers with sucrose is found to be beneficial in delaying senescence processes (Chung et al., 1997; Yakimova et al., 1996). In our study, a pulse treatment of sucrose in combination with HQS extended the vase life of cut rose flowers, suggesting that the sucrose might be required as an osmolyte for flower opening and substrate for cell wall synthesis and respiration. Also, In this study a pulse treatment with STS alone or STS followed by sucrose showed more positive effects on the vase life of cut rose flowers than water controls or sucrose alone (Figure 1, Table 2). However, no marked difference in vase life between STS and STS followed by sucrose was found, although the latter showed a slightly greater positive effect than the former. This is in agreement with the findings obtained on sweet pea flowers by Ichimura and Hiraya (1999) and on *Gypsophila* by Van Doorn and Reid (1992)

Many studies have reported on the application of sucrose in extending the vase life of cut flowers. For example, Paulin and Jamain (1982) and Kaltaler and Steponkus (1976) demonstrated the vase life of cut carnations and roses, respectively, increased following sucrose treatment. In our study, the increase in vase life by the pulse treatment with sucrose was significant in comparison to water controls. Our results are also in agreement with those of Ichimura and Hiraya (1999), who demonstrated that sucrose pulse treatment increased the vase life of cut sweet pea flowers. Although a pulse treatment of sucrose generally increases the vase life of flowers, vase life of cut rose flowers was less affected by sucrose than STS alone or STS followed by sucrose (Table 2). Furthermore, the vase life of cut rose flowers was prolonged slightly more by a pulse treatment with STS followed by sucrose than by STS alone. In addition, the greatest effect of flower diameter was recorded with STS followed by sucrose (Table 3). Therefore, it is clear that STS plays a key role in the maintenance of the vase life of cut rose flowers. The STS mechanism in extending the vase life of cut flowers is related to suppression in the induction of autocatalytic production (Ichimura and Hiraya, 1999; Mor et al., 1984; Sexton et al., 1995) although the inhibition of ethylene production was lesser than that of sucrose treatment.

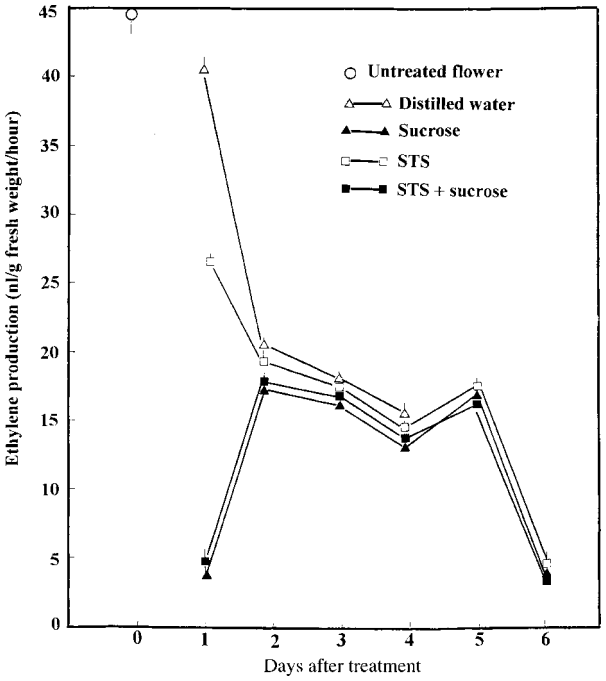

Figure 2. Ethylene production of rose cut flowers as affected by a pulse treatment of sucrose, STS, and STS followed by sucrose. Water controls or sucrose (120 g L^{-1}) contained 200 mg L^{-1} HQS. Vertical bars denote ± standard errors.

Ethylene production was more significantly inhibited by sucrose than by STS (Figure 2). STS is an ethylene action inhibitor (Eapen and George, 1997; Sarkar et al., 1999) while sucrose might directly suppress ACC oxidase or ACC synthase activity or gene expression (Nakai et al., 1997; Yu et al., 1998). Our recommendation is for an STS pulse treatment (for 2 h) followed by sucrose in combination with HQS for 10 h, which produced good results in both flower quality and vase life in rose cut flowers.

Acknowledgements. We thank Dr. Zin-Huang Liu for use of the gas chromatograph.

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硫代硫酸銀及蔗糖對玫瑰之瓶插壽命之影響

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玫瑰（*Rosa hybrida* L. cv. Diana）之切花用蔗糖每公升 0, 20, 40, 60, 80, 100 及 120 公克（處理液中含 8-hydroxyquinoline sulfate 200 mg L^{-1}）處理十小時後，放至蒸餾水中繼續瓶插處理。結果顯示，溶液每公升中含蔗糖 120 g 之玫瑰之瓶插可維持最久之壽命（約七日）。利用硫代硫酸銀之二小時或用硫代硫酸銀處理二小時後移到蔗糖溶液（120 g L^{-1}）（含 HQS 200 mg L^{-1}）處理十小時，各約可維持瓶插壽命九及十日。瓶插之玫瑰切花亦以硫代硫酸銀處理後再用蔗糖溶液處理之品質最佳。剛採收不久之玫瑰花之乙烯發生量較經不同化學藥劑溶液處理過之瓶插花朵顯著很高。與對照區相比，蔗糖對抑制乙烯發生最具效果，其次是先用硫代硫酸銀再用蔗糖之處理區，單用硫代硫酸銀之抑制效果較小。

關鍵詞：瓶插；玫瑰；乙烯發生量；硫代硫酸銀；蔗糖。