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Postharvest Physiology and Prolonging Vase Life of Cut Freesia (*Freesia refracta*)

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ABSTRACT This study was conducted to examine the effects of pulsing treatment and to develop techniques treated right after harvest by grower for extending vase life and improving flower quality in cut freesia. Thirty minutes dipping treatment of STS 2 mM followed by 20 hr pulsing in sucrose 10% + BA 10 ppm + 8-HQS 300 ppm solution showed the best results in vase life and flower quality of cut freesia when kept in vase water. This pretreatment extended vase life by 24.7% than control, and improved quality of cut freesia significantly in flower diameter, percent flowering (35.4%), fresh weight, water uptake, and carotenoid content, and depressed ethylene production and respiration rate.

Additional key words: BA, 8-HQS, ethylene, respiration, STS, sucrose

Introduction

The genus *Freesia* belongs to the family Iridaceaea, and originated in South Africa. Popularity of freesia has been increased recently due to its fragrance and availability in a wide range of colors. Freesia mostly withers only with 1~2 bottom florets opened, resulting in reduced aesthetic value and short vase life. Low percentage of flowering is probably the most serious problem with freesia inflorescences. Therefore, it would be worthwhile to improve flower development and vase life through the method of pre-treatment (pulsing), directly after harvesting.

The enhancement of senescence of cut flowers are generally related to the several factors, such as depletion of carbohydrates and other nutrient reserves, increase of ethylene production and action, and reduction of water absorption by flowers (Borochov and Woodson, 1989). Flower preservative solutions are composed of sucrose, bactericides, weak acid, anti-ethylene agent, and growth regulator.

The objectives of this study were to evaluate the effects of pre-treatments and to develop techniques for extending vase life and improving flower quality in cut freesia.

Materials and Methods

Facility and plant material

This experiment was conducted inside the chamber, max. 24℃, min. 16℃ air temperature, 61% RH, and a 12 hr photoperiod, with irradiance of 27.0 $\mu mol \cdot m^{-2} \cdot s^{-1}$ supplied by cool white fluorescent tubes. It was designed to simulate the natural conditions of general office or living room. Spikes of *Freesia refracta* cv. Golden Rocks were purchased from local grower. Freesia was harvested when the first bud showed color (normal commercial stage). Spikes were transferred immediately to the laboratory and weighed individually. Flower stalks of individual inflorescences were cut 30 cm in length without leaf. The spikes were pulsed immediately in distilled water or chemical solutions.

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Chemical pulse-treatments

The following chemicals and concentrations were used as single-component pulsing treatment (SPT) (Table 1). As a control, we used distilled water, tap water, and Chrysal AVB. Four replications were used for each treatment, and each replication contained two spikes. Cut freesia spikes were pulsed for 20 hr in each single component solution, except STS dipping treatment for 30 min, and then were placed in distilled water until the end of experiment. Based on the results from SPT experiment, combinations of the optimum concentrations in each component were tested as multi-component pulsing treatments (MPT) experiment.

In each experiment bud opening and flowering were observed daily. The vase life of floral spikes was judged as the time when the 4th floret from the bottom wilted. The diameter of the third floret of spikes was measured as flower diameter. Fresh weight and water uptake were measured daily. Ethylene production and respiration rate of each spike were measured daily. Gas samples were collected by enclosing the entire spike within a gas-tight acryl container (20×20×60 cm). Bottom end of the cut stem was held in a flask of distilled water. After 1hr, gas samples were withdrawn by 1 mL syringe. Determinations of ethylene and CO_2 content were made using gas chromatograph (Hitachi, G-3000). Carotenoid content in petals was measured by UV-spectrophotometer (Young Woo Co., LTD, Smart Plus 190 DU). It was extracted for 24 hr with 0.1% HCl/MeOH (20

Table 1. Chemical names, abbreviations, and their concentrations used in this study as single- component pulsing treatment.

Chemical name	Abbreviation	Concentration
Sucrose	S	2, 5, 10, 20 (%)
8-Hydroxyquinolin sulfate (8-HQS)	H	100, 200, 300, 400 (ppm)
Aluminum sulfate [$Al_2(SO_4)_3$]	Al	100, 200, 300, 400 (ppm)
Citric acid	C	100, 200, 400, 800 (ppm)
Benzyladenine (BA)	B	1, 2, 5, 10, 20, 40 (ppm)
Kinetin		5, 10, 20, 40 (ppm)
GA3	G	1, 2, 5, 10 (ppm)
ABA		1, 2, 5, 10 (ppm)
IAA		5, 10, 20, 40 (ppm)
AOA	A	2, 4, 8, 16 (mM)
Ethanol		1, 2, 4, 8 (%)
Silver nitrate ($AgNO_3$)		10, 20, 40, 80 (ppm)
Silver thiosulfate (STS)	ST	1, 2, 4, 8 (mM)
Spermidine	SP	50, 100, 1000, 2000 (ppm)
Putrescine		50, 100, 1000, 2000 (ppm)
Phenidone	Phe	0.1, 0.4, 1.0, 1.6, 6.4, 10.0 (mM)
Spermine		50, 100, 1000, 2000 (ppm)
Uniconazole	Uni	0.1, 1, 10, 100 (ppm)
Triton-X 100	Tr	0.001, 0.01, 0.02, 0.1 (%)

mL) in dark cool place, and absorbance was measured at 442 nm.

Results and Discussion

Based on the results from preliminary experiment(SPT experiments), effects of combination treatments were designed with STS, sucrose, BA, and 8-HQS, combined with one another with various concentrations to investigate their interaction on freesia flower vase life and quality. From the preliminary SPT study, it was found that STS and sucrose significantly extended the vase life and improved percent flowering and flower diameter of freesia. BA extended water uptake. All treatments extended vase life than control and tap water. But phenidone, LOX inhibitor, did not improve vase life and flower guality by pulsing treatment at any concentration, instead, high concentration of phenidone significantly shortened vase life (data not shown). Baker et al. (1985) reported that a vase solution containing phenidone greatly enhanced the vase life of carnations. But, our results did not agree with those results. What phenidone is not effective suggested that the stage of treatment might be much earlier or phenidone had no effect on retarding senescence (or prolonging vase life). Peary and Prince (1989) reported that LOX inhibitor such as phenidone do not appear to extend vase life in a range of cut flower species.

Treatments with MPT extended vase life and improved percent flowering more than SPT (Table 2). Flowers pulsed with (S10+B10+H300) solution for 20 hr after dipping ST2 for 30min, recorded the longest vase life, 10.1 days. This result showed 24.7% increase than 8.1 days of control. In percent flowering, MPT recorded 76.5% which was 35.4% higher than control (56.5%). When comparing with 8.8 days of vase life by (S10+B10+H300) without STS, STS pretreatment could contribute to the longer vase life (10.1 days). This result suggested that STS is effective in extending vase life, especially STS 2 mM when treated with other component was more effective than STS 4 mM.

We found that freesia is sensitive to ethylene. Fresh weight of ST2+(S10+B10+H300) treatment was very heavy and maintained higher than control until the end of experiment (Fig. 1A). Especially, freesias pulsed in the solution containing sucrose increased fresh weight over 20% until the end of experiment continuously. Similar results were found with the experiment by Woodson (1987). He found the relationship between heavy fresh weight and the highest percent of flowering. Pulsing with sucrose showed a low initial water uptake, but until the end of experiment water uptake was continuously and constantly maintained, while, the control showed a high initial water uptake and then continuous decrease(Fig. 1B). Sucrose improved the osmotic potential of flowers, thus could contribute to maintaining water content as well as promoting bud development. Prolonging the vase life of cut flowers is dependent on the continuity of water supply and carbohydrates content. Decrease of water potential was correlated with inhibition of corolla growth and flower opening(van Doorn et al., 1991). BA 10 ppm and 8-HQS 300 ppm contributed to the high water uptake during the experiment, but the pattern of water uptake showed decreasing trend. While MPT recorded low initial water uptake, water uptake of flower with MPT was maintained(Fig. 1B). And the effect of cytokinins on keeping quality of different cut flowers could be attributed to improving water uptake and maintenance of petal turgidity, and to inhibition of ethylene production action (Mor et al., 1983).

Conventionally growers leave cut freesias dry in the air after harvesting. In this case, vase life was shortened by 7.5% and only 48% percent flowering was observed (Table 2). Also, water uptake showed decreased pattern faster than that of flowers pulsed in sucrose(Fig. 1B). This results showed that quality of cut freesia was deteriorated by current method(left dry in the air until shipping). Therefore, pulsing treatments could be expected to be effective.

Treatment with ST2+(S10+B10+H300) decreased CO_2 and ethylene production than control, and STS lowered production peaks of CO_2 and ethylene when compared with S10+B10+H300 (Fig. 2). This contributed to deep and clear flower color of freesia flower (Fig. 3). Ethanol was not effective for prolonging vase life of cut freesia. Heins (1980) suggested that ethanol inhibited the conversion of ACC to ethylene in nonclimacteric tissue but not in the climacteric tissues of carnation flowers. However, Wu et al. (1992) reported that the petals of ethanol-treated flowers did not roll and ethanol treatment also decreased the flowers' sensitivity to exogenous ethylene.

Sucrose provides a respiratory substrate,

Table 2. Effects of single and multi-component pulsing treatment on vase life, flowering ratio, and flower diameter of cut freesia.

Pulsing solutions	Vase life (days)	Percent flowering[z] (%)	Flower diameter (cm)
S10[y]	7.5 d[x]	67.5 bcdef	3.1 a
B10	8.5 bcd	49.3 g	2.1 d
ST2	8.4 bcd	57.8 cdefg	2.3 bcd
H300	7.8 cd	51.8 g	2.0 d
S10+B10	8.4 bcd	77.8 ab	2.9 ab
S10+B10+H300	8.8 bcd	84.3 a	2.6 abcd
ST2+S10+B10+H300	10.1 a	76.5 ab	2.3 bcd
ST2+S10+B10+A8	8.5 bcd	71.0 abc	2.2 d
ST2+S10+B10+SP1000	9.1 b	67.8 bcde	2.2 d
S10+B10+H300+SP1000	8.4 bcd	67.5 bcdef	2.6 abcd
ST2+S10+B10+Al300	9.1 b	75.8 ab	2.4 bcd
ST4+S20+B10+H300	8.5 bcd	69.8 bcd	2.9 ab
ST4+S10+B10+H300	9.3 b	78.3 ab	2.7 abc
ethanol 1	8.0 cd	54.5 efg	2.2 d
ethanol 2	7.9 cd	51.5 g	2.2 d
ethanol 4	7.6 d	46.3 g	2.3 bcd
ethanol 8	7.8 cd	53.8 fg	2.3 bcd
Chrysal AVB	8.0 cd	58.0 cdefg	2.2 d
Tap Water	7.5 d	56.8 defg	2.4 bcd
Conventional(Air conditioned)	7.5 d	48.0 g	2.4 bcd
Control(distilled water)	8.1 cd	56.5 defg	2.2 d

[z]Percent flowering = $\frac{\text{No. of fully open flowers}}{\text{No. of total flower buds}} \times 100$

[y]See Table 1.

[x]Mean separation within columns by Duncan's multiple range test, 5% level.

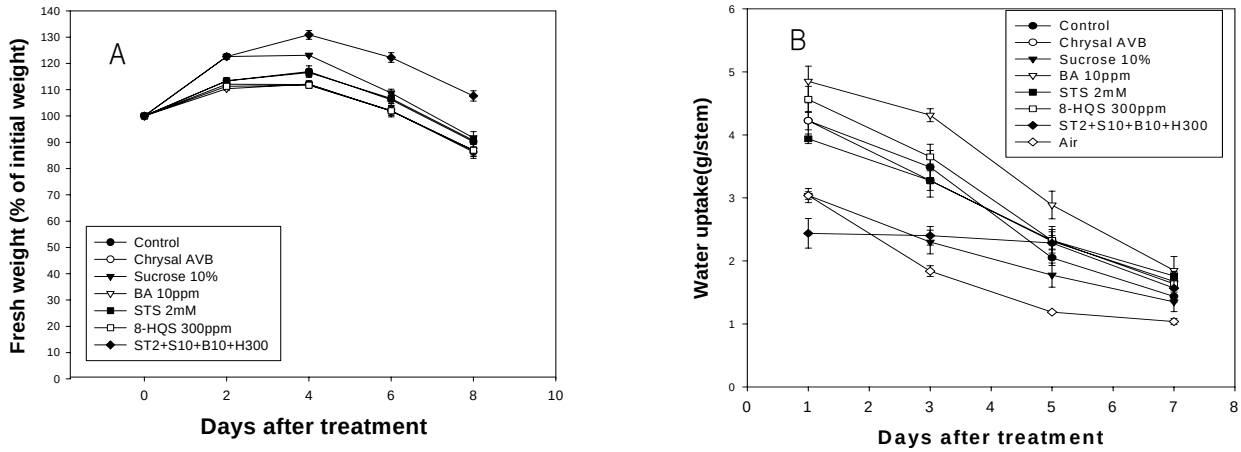

Fig. 1. Effects related to single and multi-component pulsing treatment on fresh weight (A) and water uptake (B) of cut freesia.

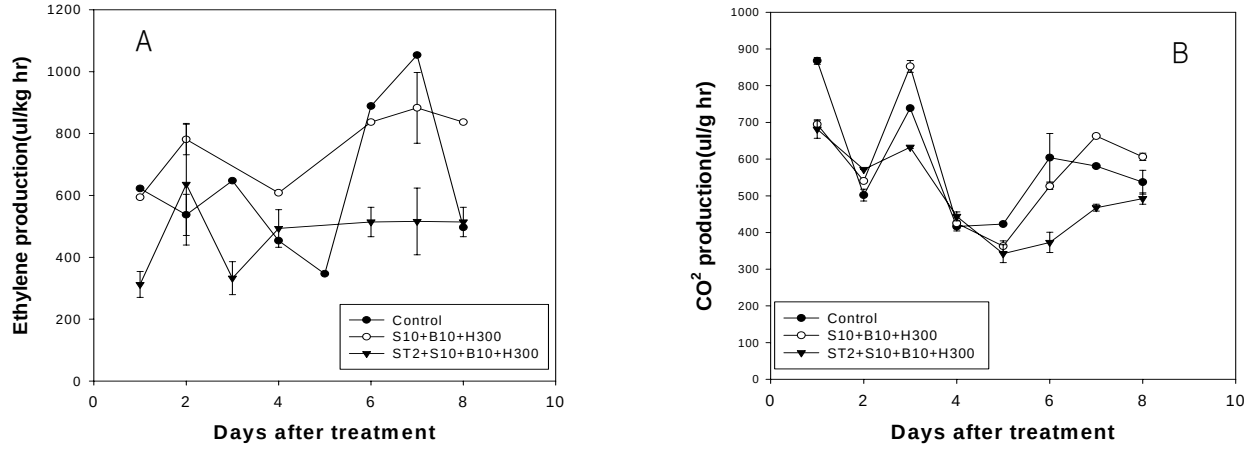

Fig. 2. Effects of multi-component pulsing treatment on ethylene (A) and CO_2 production (B) of cut freesia.

Fig. 3. Effect of multi-component pulsing treatment on vase life in cut freesia. Right: STS 2mM+(Sucrose 10%+BA 10ppm +8-HQS 300 ppm). Left: Control.

while the bactericides control harmful bacteria and prevent bacterial plugging of water conducting tissues. In many cases the senescence of flower petals was delayed by applying cytokinins(Lukaszewska et al., 1994; Mayak and Dilley, 1976). Eisinger (1977) found that carnations treated with BA are less sensitive to exogenous ethylene. Also, BA treatment was almost as satisfactory as STS treatment (Serek and Andersen, 1993). Indeed, several authors have proposed that cytokinins be a natural anti-senescence hormone in flower petals (Mor et al., 1983).

Generally, vase life was extended by 1 or 2 days in MPT. The best result in prolonging vase life was observed in ST2+(S10+B10+H300) treatment, 24.7% longer than control. Flower quality also was simproved by MPT with increased flower diameter (Table 2). As a whole, ST2+(S10+B10+H300) was recommended as the most effective treatment in enhancing vase life and flower quality (Fig. 3). It was observed that heavier flowers had longer vase life. The most effective treatment in prolonging vase life, ST2+(S10+B10+H300) showed higher water uptake until the end of experiment. Addition of sucrose significan-

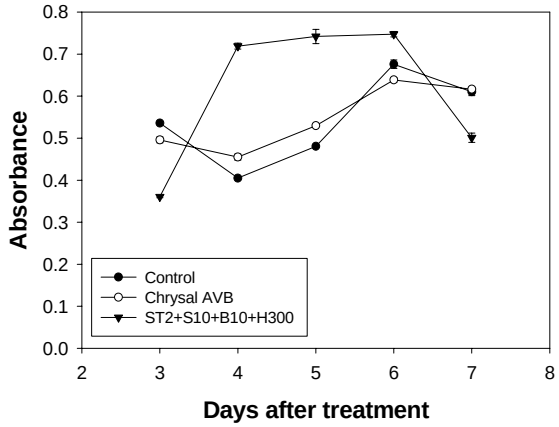

Fig. 4. Effects of multi-component pulsing treatment on carotenoid content in petals of cut freesia.

tly increased fresh weight and delayed senescence in fully developed flowers, and enhanced the opening of flower buds (van Meeteren et al., 1995). Sucrose was also thought to supply depleted carbohydrate reserves in cut flowers, thereby helped maintain metabolic activities (Coorts, 1973). Addition of BA significantly increased water uptake and dipping with STS decreased ethylene action, resulting in delaying the senescence of freesia. Also, carotenoid content were higher than control and resulted in enhancing petal color (Fig. 4).

Literature Cited

Baker, J.E., C.Y. Wang, and D.E. Terlizzi. 1985. Delay of senescence in carnations by pyrazon, phenidone analogues, and tiron. HortScience 20(1):121-122.

Borochov, A. and W.R. Woodson. 1989. Physiology and biochemistry of flower petal senescence. Hort. Rev. 11:15-43.

Coorts, G.D. 1973. Internal metabolic changes on cut-flowers. HortScience 8: 195-198.

Eisinger, W. 1977. Role of cytokinin in carnation flower senescence. Plant Physiol. 59:707-709.

Heins, R.D. 1980. Inhibition of ethylene synthesis and senescence in carnation by ethanol. J. Amer. Soc. Hort. Sci. 105: 141-144.

Lukaszewska, A.J., J. Bianco, P. Barthe, and M.T. Le Page-Degivry. 1994. Endogenous cytokinin in rose petals and the effect of exogenously applied cytokinins on flower senescence. Plant Growth Regulation 14:119-126.

Mayak, S. and D.R. Dilley. 1976. Effect of sucrose on response of cut carnation to kinetin, ethylene, and abscisic acid. J. Amer. Soc. Hort. Sci. 101(5):583-585.

Mor, Y., H. Spiegelstein, and A.H. Halevy. 1983. Inhibition of ethylene biosynthesis in carnation petals by cytokinin. Physiol. Plant. 71:541-546.

Peary, J.S. and T.A. Prince. 1989. Cut flower vase ife is little-affected by lipoxygenase inhibitors. HortScience 24(5):808-809.

Serek, M. and A.S. Anderson. 1993. AOA and BA influence on floral development and longevity of potted 'Victory Parade' miniature rose. HortScience 28(10):1039-1040.

Van Doorn, W.G., A. Clerke, and A. Boekestein. 1991. Bacteria as a cause of vascular occlusion in cut fronds of Adiantum raddianum : a scanning electron microscope study. Sci. Hort. 48:299-309.

Van Meeteren, U., H. van Gelder, and A.C. van de Peppel. 1995. Aspects of carbohydrate balance during floret opening in freesia. Acta Hort. 405:117-122.

Woodson, R.W. 1987. Postharvest handling of bud-cut freesia flowers. HortScience 22(3):456-458.

Wu, M.J., L. Zacarias, M.E. Saltveit, and M.S. Reid. 1992. Alcohols and carnation senescence. HortScience 27(2):136-138.

절화 프리지아의 수확후 생리 및 수명연장

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초 록

본 실험은 절화 프리지아의 수확 후 생리 및 화학물질의 처리효과를 규명하고, 프리지아의 수명연장과 품질증진을 위해 수확 후 재배자가 바로 한번만 처리해도 소비자가 손쉽게 고품질의 꽃을 감상할 수 있는 기술을 개발하는데 그 목적이 있다. Sucrose 처리로 개화율의 증진과 생체중 증가효과를 기대할 수 있으며, BA와 8-HQS는 절화의 수분흡수를 좋게 해주어 품질증진에 효과가 있었다. STS 2mM을 30분 전처리후 sucrose 10% + BA 10ppm + 8-HQS 300ppm 용액에 20시간 처리한 경우가 절화 프리지아의 수명연장과 품질향상에 가장 좋은 효과를 보였다. 혼합용액의 전처리로 수명을 24.7% 연장시켰고, 개화율(35.4%), 화경, 생체중, 수분흡수량, 카로티노이드 함량을 증가시켰으며, 에틸렌 생성과 호흡은 감소시켰다.

추가 주요어 : benzyladenine (BA), 8-HQS, STS, sucrose, 에틸렌, 호흡