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Effects of Chemical Compounds on Vase Life and Microbial Growth of Cut Calla Flowers

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ABSTRACT

The opening process of cut calla flower was faster at 30℃ than at lower temperatures as it could be expected from its tropical origin. Gibberellin enhanced the flower opening, however, it also speeded up senescent. Silver thiosulfate was effective in prolonging the vase life of the cut calla flower. Silver thiosulfate reduced ethylene generation by the flower and inhibited microbial growth in the flower stalk. Reduction in ethylene generation and inhibition of microbial growth is thought to be responsible for the extension of the vase life of cut calla flowers by silver thiosulfate.

Key words : calla, vase life, silver thiosulfate, microbial growth

INTRODUCTION

Calla is a bulbous plant of Araceae family originated from tropical Africa(Heywood, 1993). The floral structure of calla is simple. The spadix flower of calla is enclosed by a spathe and this spathe looks like a flower having ornamental value. Most of the cultivated calla flowers are white, though some varieties with colored flowers are known. In Korea, callas are grown mainly in green houses and harvested as cut flowers from December to next May. Since it resembles lily flower, one of the most demanding cut flowers, and is produced during the winter season when other flowers are not produced in large amounts, the demand for calla is steadily increasing.

Cut flowers have only limited vase life. After a long-distance transportation and/or a long-term storage, the vase life of a cut flower is significantly shortened and the quality of a cut flower is rapidly deteriorated. Some cut flowers lose their freshness, fail to open, and become senescent. The longevity of a cut flower is influenced by many factors such as amount of moisture, concentration of nutrients, ethylene generation, blockage of reticulate vessels by microorganisms, cultivation condition, harvest time, and storage condition(Answerwadekar and Patil, 1986; Beyer, 1976; Borochov and Woodson, 1989; Goszcynska and Rudnicki, 1988; Mayak and Dilley, 1976; Sacalis and Nichils, 1980). Microorganisms play an important role by putrefying stalks, blocking vessels, and by inhibiting the supply of water and nutrients(van Doorn et al., 1991; Zagory and Reid, 1986).

Numerous studies have been conducted to extend the

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vase life and to prevent quality deterioration of cut flowers, and as a result, various pretreatment agents and flower preservatives have been developed. Sucrose, silver thiosulfate(STS), silver nitrate($AgNO_3$), 8-hydroxyquinoline sulfate(8-HQS), aluminum sulfate,(aminooxy)acetic acid(AOA), and some plant hormones have been used as effective components of pretreatment agents and flower preservatives(Apelbaum and Katchannsky, 1977; Beyer, 1976; Goszcynska and Rudnicki, 1988; Mayak and Dilley, 1976; Mor and Halevy, 1984; Reid et al., 1980). These agents have been known to increase the longevity and improve the quality of cut flowers by supplying moisture and nutrients(Answerwadekar and Patil, 1986), by inhibiting the growth of microorganisms(Gorim et al., 1985), and by decreasing the generation of ethylene gas(Beyer, 1976; Goszcynska and Rudnick, 1988; Mayak and Dilley, 1976).

In Korea, though numerous studies have been conducted to increase the vase life of cut flowers such as rose(Ahn and Um, 1991), carnation(Chung et al., 1986), gladiolus(Song et al., 1992), lily(Kim and Suh, 1997), no study has been performed with calla. Moreover, unlike other cut flowers, only the flower and stalk of calla is used as cut flowers. This study is concerned with the influences of temperature and chemical agents on the microbial growth and the vase life of cut calla flowers.

MATERIALS AND METHODS

Calla flowers

Pure white calla(*Zanterdeschia aethiopica*) flowers of childsiana variety grown in a local green house in Yosu city, Chonnam, Korea, were used for this study. Flowers harvested at the stage II in Fig. 1 were immediately transported to the laboratory, cut to 40 cm with a razor blade, and then soaked in distilled water for an hour prior to treatments.

Effect of temperature on opening of flower

Cut flowers were placed in 100 ml mass cylinders filled with 60 ml distilled water(1 flower per each cylinder) and openings of the cylinders were sealed with aluminum foil. The flowers were stored in growth chambers of 20℃, 25℃, or 30℃ for three weeks, and the amounts of water uptake and the diameters of the flowers were measured periodically. Other storage conditions were 16h daylight, 400 umol m-2 s-1 light intensity, and 70% relative humidity.

Effect of chemical compounds on opening of flower

Chemical components used in this study were 5% sucrose, 4 mM STS, 30 ppm $AgNO_3$, and 100 ppm 8-HQS. Plant hormones were used at concentrations of 10 ppm(gibberellin [GA_3], benzyladenine [BA], -naphthalene acetic acid [NAA], indole acetic acid [IAA]), or at a concentration of 100 ppm(paclobutrazol [PP333]).

For pulsing with the chemicals, flowers, six flowers per each treatment, were soaked in a flask containing the chemical for an hour at room temperature. Immediately after pulsing, flowers were placed in 100 ml mass cylinders, one flower per cylinder, filled with 60 ml distilled water. Amount of water uptake, microbial density, diameter and vase life were checked periodically during storage of flowers in a growth chamber of 20～25℃ and 16h daylight. STS-pretreatment was done by soaking flowers for 1h in the solution, storing them for 24h without water, and then placing them in cylinders with distilled water.

Effect of STS-pretreatment on ethylene generation

Stalks were removed from STS-treated or non-treated flowers at each stage in Fig. 1. Flowers without stalk were placed in 300 ml gas-tight containers(one flower per each container), and stored for 24h at room temperature after sealing the containers. One mili liter

of gas from each container was removed and the amount of ethylene generated was analyzed by gas chromatography(5890 Series-2 gas chromatograph, Hewlett Packard, USA; activated alumina column; flame ionization detector; 100℃).

Determination of microbial population

About 1cm of lowermost stalk segment was cut from each flower with a sterile razor blade in a clean bench. Cut stalk segment was crushed with 10 volumes of sterile distilled water using a mortar and pestle. Resultant solution was further diluted with sterile saline, and appropriate decimal dilutions were streaked onto Nutrient agar(Difco) plates. Plates were incubated for 24~48h at 30℃ before enumeration.

RESULTS AND DISCUSSION

Influence of temperature and pretreatments on opening of cut calla flowers

The opening process of calla flower is shown in Fig. 1. Calla flowers are usually harvested at stage II(initial opening stage) when the opening of spathe is about 11 ~14 mm. If the flowers are harvested at stage I(unopening stage), the flowers may fail to open and lose their value as cut flowers. All of the calla flowers used in this study were harvested at stage II, and the vase life of a flower was defined as a time to reach stage V(initial senescent stage) from stage II.

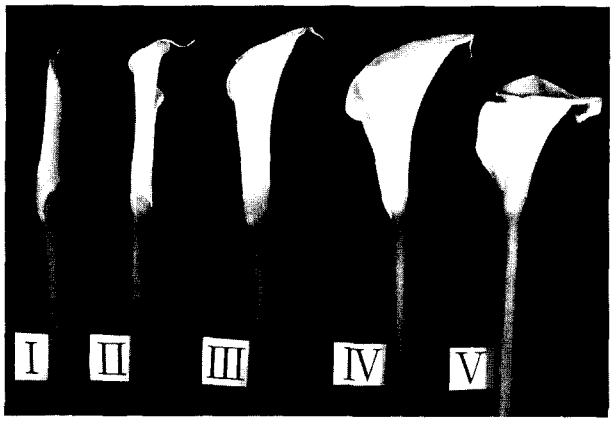

Fig. 1. Opening stages of cut calla flowers.
I, unopened stage; II, initial opening stage;
III, 50% opened stage; IV, full bloom stage;
V, initial senescent stage.

The opening process of cut calla flowers was significantly influenced by temperature(Fig. 2), as it could be expected from the tropical African origin of the plant. The times required to reach the full-blooming stage(stage IV in Fig. 1) were 4 days, 5 days, and 8 days, respectively, at temperatures of 30℃, 25℃, and 20℃ . Aging process was also slower at low temperatures than at higher temperatures. When the flowers were placed at room temperature(5~22℃), opening process took place very slowly taking more than 11 days for full-blooming.

The opening process of cut calla flowers was also influenced by pretreatments(Fig. 3 and Table 1). The opening process was enhanced by GA, IAA and

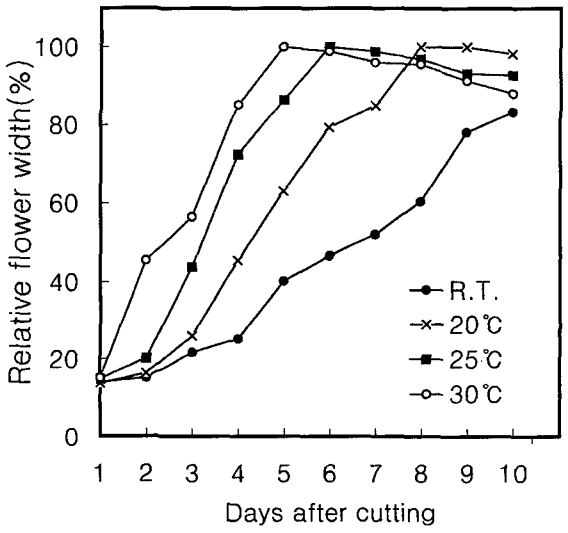

Fig. 2. Effect of temperature on opening of cut calla flowers.
* R.T. = Room Temperature(5-22℃)
Relative Flower Width(%) =

$$\frac{\text{width at the time of measurement}}{\text{width at the time of full bloom}} \times 100$$

sucrose-pretreatments. GA and IAA are thought to enhance the opening by promoting cell elongation. Sucrose is thought to enhance the opening by acting as an energy source for the process. The opening process was hindered by PP333, BA, 8-HQS+sucrose and STS-pretreatments(Fig. 3 and Table 1).

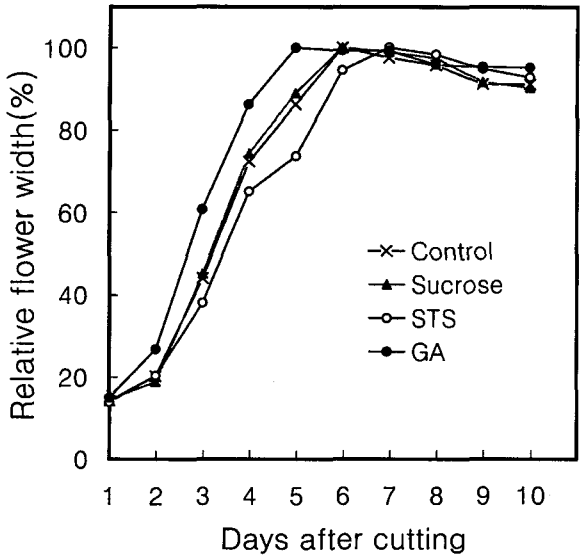

Fig. 3. Effects of STS, sucrose, and GA on opening of cut calla flowers. Refer to Fig. 1 for the opening stages.

Effect of chemical agents on water uptake, vase life and ethylene production of cut calla flowers

STS, sucrose, $AgNO_3$, and 8-HQS+sucrose was effective in increasing the vase life of cut calla flower. STS treatment was most effective and the vase life could be extended by 1.5 days by the treatment(Table 1). However, STS treatment was not as effective in increasing the vase of with cut calla flowers as in increasing those of rose and other cut flowers. This might be a result of differences in the stem structures of the flowers. Gibberellin and PP333 promoted senescence of cut calla flowers and slightly shortened the vase life of the flowers(Table 1). NAA significantly enhanced the water-uptake by the flowers, however, no significant influence on the vase life was observed.

Since STS was most effective in extending the vase life, the influence of STS on ethylene generation was studied at various stages of flower opening(Fig. 4). The generation of ethylene gas was steadily increased during the opening process, reached a maximum at full-bloom stage(stage IV), and then decreased at the senescent stage(stage V). Ethylene generation at each stage of

Table 1. Effect of chemical compounds on vase life and water uptake of cut calla flowers.

Chemical compounds	Floral development		Vase life	
	Days to full blooming	Water uptake (ml)	Days to senescence	Water uptake (ml)
Control	5.3b*	27.3b	7.6b	35.8b
STS(4 mM, pretreatment)	5.9ab	28.5b	9.1a	38.5b
STS(4 mM, pulsing)	5.7b	29.0b	8.6ab	37.4b
Sucrose(5%)	4.9bc	22.7c	8.2ab	32.1c
$AgNO_3$(30 ppm)	5.1b	24.3bc	7.4b	34.1b
8-HQS(100 ppm)	5.4b	27.5b	7.8b	34.7b
$AgNO_3$ + Sucrose	5.0b	23.1bc	8.1ab	29.0c
8-HQS + Sucrose	6.1ab	29.1b	8.7ab	34.2b
GA_3(10 ppm)	4.4c	28.5b	6.2c	33.9bc
BA(10 ppm)	5.9ab	25.4b	7.4b	35.0b
NAA(10 ppm)	5.4b	34.8a	7.7b	44.4a
IAA(10 ppm)	4.7bc	26.6b	7.2b	33.5bc
PP333(100 ppm)	6.5a	25.5b	6.9bc	33.2bc

*Mean separation in columns by Duncan' s multiple range test, 5% level.

flower opening was drastically reduced by STS treatment. At stage IV, ethylene generation by STS treated flower was 0.5 nl/g/h which corresponded to only one-fifth on the amount generated by untreated flower(2.4 ng/g/h). The changes in ethylene generation during flower opening process of calla was similar to that of carnation(Lee et al. 1997). However, the amount of ethylene generated by cut calla flower(2.4 nl/g/h) was much less than that generated by cut carnation flower(ca. 50 nl/g/hr)(Lee and Lee, 1989). The difference is thought to be due to the differences in the flower structures. A carnation flower has many petals, compared to a single spathe of calla, and most of the ethylene is known to be generated from these petals(Lee and Lee, 1989).

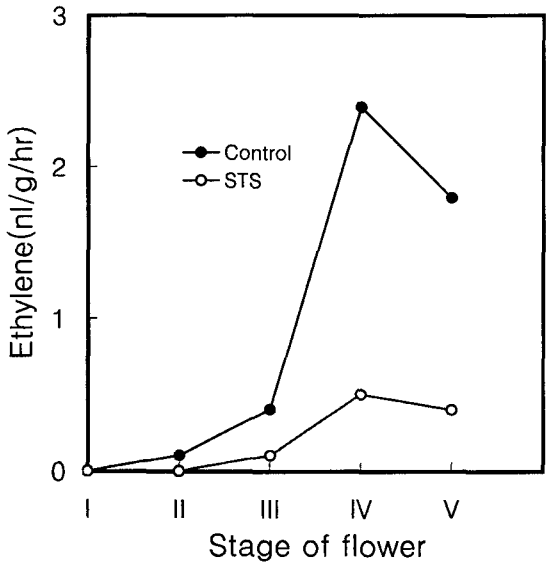

Fig. 4. Effect of STS treatments on ethylene production at various opening stages of cut calla flowers.

Effect of chemical agents on microbial growth during storage of cut calla flowers

The number of microorganisms in stalks increased significantly during the storage of cut calla flowers in the presence or absence of STS(Fig. 5). STS inhibited the growth of microorganisms, though the inhibiting activity decreased as time went on, and STS was found to be more effective if it is used for pulsing just prior to storage than used for pretreatment just after harvest(Fig. 5). Less microorganisms were found when the flowers kept in tap water than when kept in distilled water(Fig. 5). Chloride in tap water is thought to be effective in inhibiting microorganisms in flower stalks.

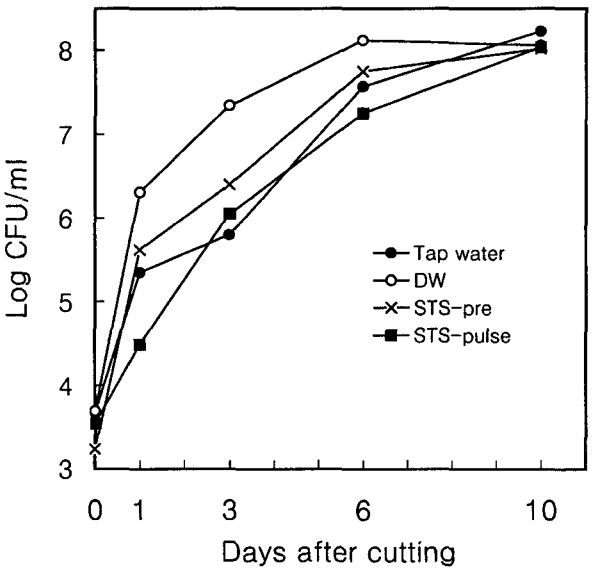

Fig. 5. Effect of STS treatments on microbial growth during storage of cut calla flowers.

The inhibiting activities of most commonly used components of flower preservatives, STS, $AgNO_3$, 8-HQS and sucrose, were studied. Sucrose was found to inhibit the growth of microorganisms in the flower stalk(Fig. 6). Cut flowers may become metabolically more active in the presence of sucrose, an easily utilizable energy source. This enhanced metabolic activity is thought to be responsible for the inhibiting activity. STS and $AgNO_3$ showed similar inhibiting activities and were more effective than 8-HQS(Fig. 6). The effectiveness of STS and $AgNO_3$ is known to be due to Ag^{++} ions(Lee et al., 1980; Veen, 1979). $AgNO_3$, when used alone, is known to be not so effective in

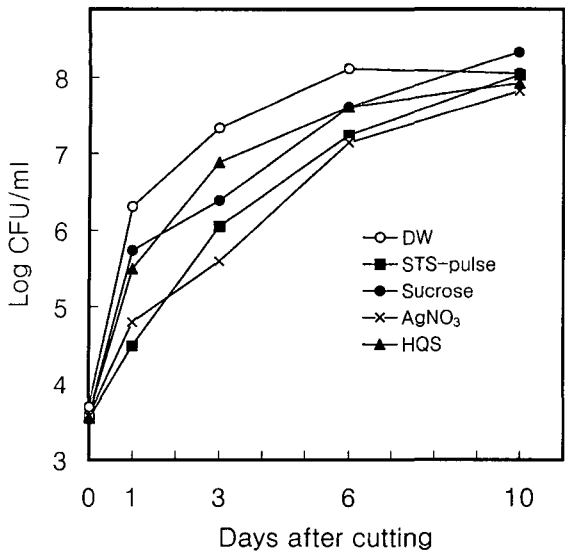

Fig. 6. Effect of pulsing with chemical agents on microbial growth during storage of cut calla flowers.

extending the vase lives of cut flowers because of the difficulty in the transportation of Ag^{++} ions through the vessels of plants. This difficulty can be circumvented if $AgNO_3$ is used with sodium thiosulfate(as STS). The transportation of Ag^{++} ions in planst can be improved in the presence of thiosulfate ions(Chung et al. 1986). STS, which extened the vase life of cut calla flowers, has been reported to be effective in extending the vase lives of carnation(Chung et al., 1986), rose(Ahn and Um, 1991), gladiolus(Song et al. 1992), and lily(Kim and Suh, 1997). Ag++ ions are known to increase the vase life of cut flowers by reducing ethylene generation and inhibiting microbial growth(Lee et al., 1980; Veen, 1979).

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LITERATURE CITED

Ahn K. Y. and K. S. Um, 1991. A study on vase life extension of cut roses. J. Kor. Soc. Hort. Sci. 32:490-496.

Answerwadekar, K. W. and V. K. Patil. 1986. Vase life studies of gladiolus(*Gladiolus grandiflora*). Acta Hort. 181:279-283.

Apelbaum, A. and M. Katchansky. 1977. Improving quality and prolonging vase life of bud cut flowers by pretreatment with thiabedazole. J. Amer. Soc. Hort. Sci. 102:623-625.

Beyer, E. M. 1976. A potent inhibitor of ethylene action in plants. Plant Physiol. 58:268-271.

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

Chung, G. Y., J. S. Lee and Y. R. Kim. 1986. Effects of silver nitrate and silver thiosulfate on the vase life and senescence of cut carnation flowers. J. Kor. Soc. Hort. Sci. 27(3): 275-282.

Gorim, N., G. Staby, W. Klop, N. Tippet and D. L. Leussing, Jr. 1985. Quality measurements of carnation treatment solution in relation to flower silver distribution and longevity. J. Amer. Soc. Hort. Sci. 110: 117-123.

Goszcynska, D.M. and R.M. Rudnicki. 1988. Storage of cut flowers. Hor. Rev. 10:35-62.

Heywood V. H., 1993. Flowering plants of the world. Andromedia Oxford Ltd., p309.

Kim J. H. and J. K. Suh. 1994. Effect of microorganism on vase life of cut lily. RDA. J. Agri. Sci. 36:37-43.

Lee J. S. and P. O. Lee. 1989. Changes in ethylene production, ACC content, and EFE activity of various floral parts during senescence of cut carnations as affected by silver thiosulfate. J. Kor. Soc. Hort. Sci. 30(4): 319-330.

Lee M. M., S. H. Lee and K. Y. Park. 1997. Effects of spermine on ethylene biosynthesis in cut carnation(*Dianthus caryophyllus* L.) flowers during senescence. J. Plant Physiol. 151:68-73.

Lee J. S., J. Y. Pyon and Y. R. Kim. 1980. Improving guality and prolonging vase life of cut flowers 1. Effect of floral preservative on longevity, quality and ethylene production of cut carnations. J. Kor. Soc. Hort. Sci. 21(1):98-107.

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. 101:583-585.

Mor, Y., A. H. Halevy, A. M. Kofranek and M.S. Reid. 1984. Postharvest handling of lily of the Nile flowers. J. Amer. Soc. Hort. Sci. 109:494- 497.

Reid, M.S., D. S. Farnham and E.P. McEnroe. 1980. Effect of silver thiosulfate and preservative solutions on the vase life of miniature carnations. HortScience 15:807-808.

Sacalis, J.N. and R. Nichils. 1980. Effects of 2, 4-D uptake on petal senescence in cut carnation flowers. HortScience 15:499-500.

Song C. Y., D. G. Shin, I. S. Woo and J. S. Lee. 1992. Studies on the vase life extension of cut gladiolus. J. Kor. Soc. Hort. Sci. 33(1):95-101.

van Doorn, W. G. and Y. de Witte. 1991. Effect of dry storage on bacterial counts in stems of cut rose flowers. HortScience 26:1521- 1522.

Veen, H. 1979. Effects of silver on ethylene synthesis and action in cut carnations. Planta 145:467-470.

Zagory D. and M. S. Reid. 1986. Role of vase solution microorganism in the vase life of cut flowers. J. Amer. Soc. Hort. Sci. 111:154-158.

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