Floriculture and Ornamental Biotechnology ©2009 Global Science Books

Effect of Different Concentrations of Four Preservative Solutions on Tuberose (*Polianthes tuberosa* L.) Cut Flower Vase-Life

Mahroo Sadat Motaghayer[1] • Mahmood Esna-Ashari[2*]

[1] Department of Horticultural Sciences, Faculty of Agriculture, University of Applied Science and Technology, Isfahan, Iran
[2] Department of Horticultural Sciences, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran

Corresponding author: * **m.esnaashari@basu.ac.ir**

ABSTRACT

The effect of different concentrations of 4 preservatives, including 8-Hydroxyquinoline sulfate (8-HQS), citric acid, silver nitrate and sucrose in 3 kinds of water (Hamedan city tap water, Hamedan cooled boiled water and double distilled water) on vase-life of tuberose (*Polianthes tuberosa* L.) 'Gol Dorosht' cultivar cut flower was studied. The best preservative solution for tuberose cut flower was 2% sucrose in double distilled water, which performed significantly better than other treatments.

Keywords: 8-hydroxyquinoline sulfate, citric acid, silver nitrate, sucrose
Abbreviations: 8-HQC, 8-hydroxyquinoline citrate; **8-HQS**, 8-hydroxyquinoline sulfate; **$AgNO_3$**, silver nitrate; **GA_3**, gibberellic acid; **STS**, silver thiosulfate complex

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.), a member of the Agavaceae family, is a cormous perennial plant and native to Mexico (De Hertogh and Le Nard 1993). Tuberose flowers have a very pleasant fragrance and are beautiful in bouquets and suitable for interior decoration. Postharvest vase-life of tuberose cut flower is usually 3 days for each floret without using preservatives. Generally less than 50% of buds open after harvest (Reid 1996). There are different flower preservatives that provide water and energy which are required to improve flowers vase-life and to keep their quality over the period of presentation (Salunkhe *et al.* 1989; Halevy and Kofranek 1997; reviewed in Balas *et al*. 2006).

Required energy for cell activities is prepared by sugars that oxidize in mitochondria and results in preservation of other organelles' structure and function (Dilley and Carpenter 1975). Sucrose is the main translocatable sugar in plants (Bieleski 1977). The addition of sugar to vase solution causes flower buds opening in *Gladiolus hybrids* and *Gypsophila* spp. (Halevy and Mayak 1981). Ichimura (1998) and Ichimura and Hiraya (1999) reported that continuous sucrose treatment markedly promoted floret opening and extended vase-life in sweet pea (*Lathyrus odoratus*) cut flowers. It has also been reported that continuous sucrose treatment plus silver thiosulfate complex (STS) pulsing extended mini-gladiolus cut spikes' vase-life and maintained flower quality (Meir *et al.* 1995). Liao *et al.* (2000) indicated that an STS pulse treatment for 2 hrs followed by sucrose treatment in combination with 8-hydroxyquinoline sulfate (8-HQS) preserved rose flowers' quality and increased their vase-life. Reid (1996) reported a 24 hr pre-treatment with 20% sucrose solution and 250 mg/l 8-hydroxyquinoline citrate (8-HQC) to increase tuberose florets quality and cut flower vase-life.

Microorganisms, which exist in vase water, prevent water absorption by some cut flowers and have negative effect on their vase-life extension. So, sugar should be used with germicides in combination with flower preservative solutions. Citric acid prevents blockage of xylems via pH lowering and reduces bacterial propagation in stem section (Nowak and Rudnicki 1990). 300 mg/l citric acid treatment has been effective on tuberose cut flower vase-life for about 7 days (Jowkar and Salehi 2005).

Studies by Parups and Peterson (1973) showed that both HQC and HQS have anti-bacterial and anti-ethylene effects. Useful germicide properties of 8-HQC have also been proved to maintain the quality and extend the vase-life of some cultivars of rose, scilla and gypsophila (Jones and Hill 1993).

Anti-ethylene compounds such as STS and silver nitrate ($AgNO_3$) delay flower senescence and prevent their fall (Kofranek 1985; knee 1992). STS has frequently been used as a pulse treatment for flowers preservation (Han 1998) and caused vase-life increase by preventing ethylene effect (Mor *et al.* 1981). Goszczynska (1989) introduced gibberellic acid (GA_3) at 200 mg/l or 50 mg/l $AgNO_3$ plus 2% sucrose as the best solutions for the well-maintenance of daffodil Dutch varieties cut flowers. Doss (1986) also indicated the effect of $AgNO_3$ at 25 mg/l on extending daffodil Dutch varieties cut flowers' vase-life. A 50 mg/l $AgNO_3$ solution showed a positive effect on increasing postharvest life of tuberose cut flowers for about 8 days (Saini *et al.* 1994; Anjum *et al.* 2001). As there were some different preservative solutions in the literature recommended for tuberose cut flowers, the main purpose of the present study was to find the best one enhancing the vase-life of Iranian cv. 'Gol Dorosht', so that the cut flowers could be kept longer under home conditions and for interior decoration.

MATERIALS AND METHODS

Tuberose flowers cv. 'Gol Dorosht' were purchased from a tuberose grower of Mahallat city in the west of Iran, where the highest amount of flowers and ornamentals are produced. Stems were cut at 70 cm and trimmed to 60 cm. Required concentrations of preservatives were prepared by dissolving chemicals in 3 kinds of water: Hamedan city tap water, Hamedan cooled boiled water and double distilled water (DDW) which is prepared by twice purification of water through distillation to remove the salts as much as possible. All chemicals were supplied by the Merck Co., Germany. This study was carried out as a factorial experiment

Received: 3 May, 2009. Accepted: 15 July, 2009.

Short Communication

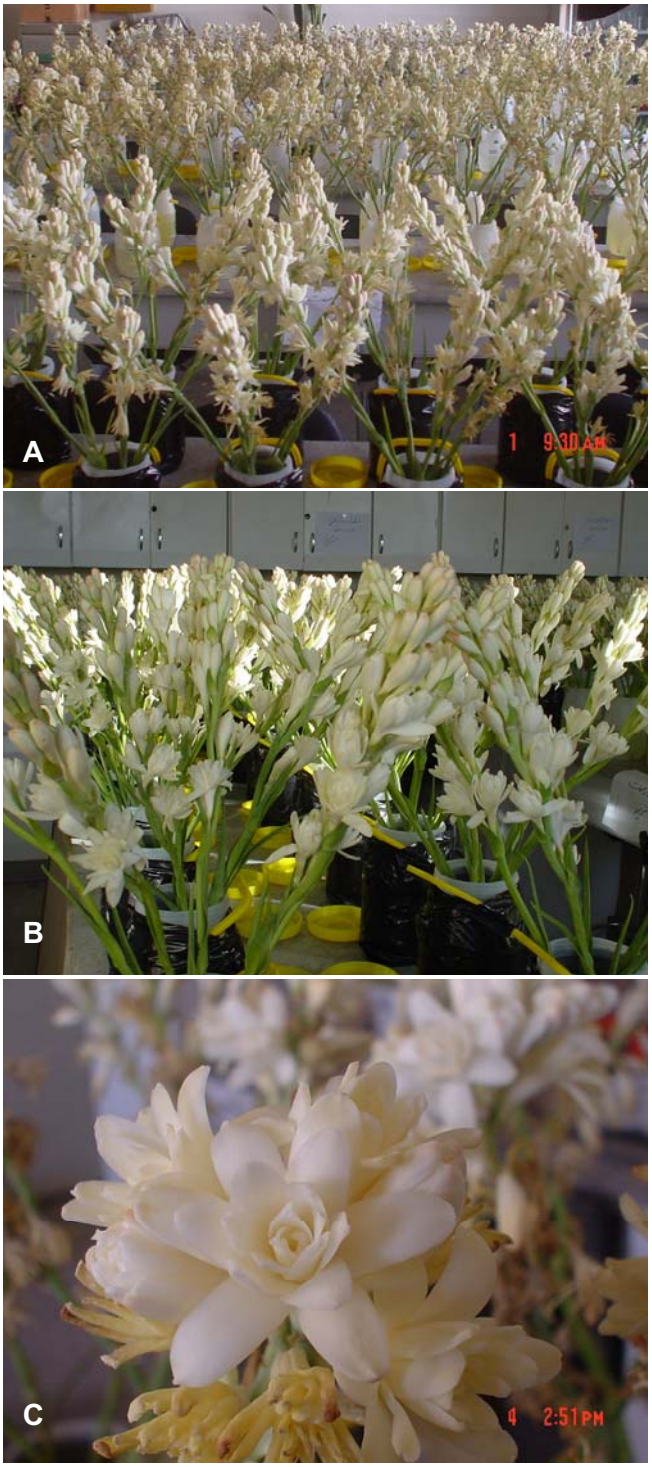

Fig. 1 (**A, B**) Broad view of cut flowers in different treatments; (**C**) Healthy and wilted tuberose flowers in cut flower solution.

based on a complete randomized design with 3 replications. A vase containing 5 cut stems was considered for each replication (**Fig. 1A**).

Different concentrations of chemicals in preservative solutions were prepared as follows:

1) 8-HQS at 0, 100, 200 and 300 mg/l
2) Citric acid at 0, 150, 300 and 450 mg/l
3) $AgNO_3$ at 0, 50 and 100 mg/l
4) Sucrose at 0, 2, 4 and 8% (w/v)

After the application of preservative solutions, the cut flower vase-life was considered as the time in which a minimum of 4 healthy florets remained on each inflorescence. Flowers were kept in laboratory with maximum and minimum temperature of 25 ± 3 and 21 ± 3ºC, respectively (Jowkar and Salehi 2005). In order to keep the flowers similar to the domestic use, the vase solutions were not changed and the stems were not re-cut during the experiment. Data were collected on a daily basis by recording the number of semi-opened, opened and wilted florets and analyzed using MSTAT-C software and the means were compared by Duncan's Multiple Range Test at $P < 0.05$ and $P < 0.01$.

RESULTS AND DISCUSSION

Different concentrations of 8-HQS had no effect on extending postharvest life of tuberose cut flowers. Although 8-HQS shows micro-biocide effects, in this experiment it did not have any impact on tuberose cut flower vase-life. Ichimura (1998) also confirmed that HQS alone has little effect on extending vase-life and preventing ethylene production in snapdragon (*Antirrhinum majus* L.) cut flowers.

Citric acid could maintain tuberose cut flower vase-life a little longer when it was used at 450 mg/l in DDW (**Table 1**), although, in general, it had little effect on flower life longevity. Citric acid increases cut flowers life because it inhibits microorganisms' growth through the reduction of pH in preservative solutions (Alvarez *et al.* 1994). Jowkar and Salehi (2005) indicated that 450 mg/l citric acid in sterilized DW maintained tuberose 'Gol Dorosht' cultivar cut flower longevity for about 9 days, compared with control which was 6.25 days, while in this study even citric acid solution made in DDW had no effect on postharvest life of this cut flower (**Table 1**). Using sterilized DDW for preparation of preservative solutions plus geographical conditions of area and also flower growth conditions before harvest which potentially could affect vase-life longevity of cut flowers, are probably the reasons of these differences in results, and further studies are needed to clarify this with supporting data.

All concentrations of $AgNO_3$ had a negative effect on tuberose cut flower vase-life as the longest flower life (5 days) was seen in solutions without $AgNO_3$ (**Table 1**). This result is in agreement with the findings of Alvarez *et al.* (1994) and Jowkar and Salehi (2005). Jowkar and Salehi (2005) showed that the concentrations of 50 to 150 mg/l $AgNO_3$ caused florets to wilt and top flower spikes to bend. They have also used different concentrations of STS (0.4-1.2 mM) and reported that both semi-opened and opened florets showed wilting and petal tip-burn at the fourth day. These symptoms were observed earlier in the concentration of 1.2 mM.

One of the main factors reducing the vase life of many cut flowers is ethylene, which directly accelerates senescence and results in flower drop (Kofranek 1985; Nowak and Rudnicki 1990). Anti-ethylene compounds, especially STS, can overcome the ethylene effects, and prolong the flower vase life (Kofranek 1985; Nowak and Rudnicki 1990). In the Jowkar and Salehi's experiment, STS-treated flowers had a short vase life and also showed the symptoms of Ag+ toxicity. Similar results have also been reported by Finger *et al*. (1999) and Alvarez *et al*. (1994) in which silver nitrate reduced the vase life of *Strelitzia reginae* and tuberose cut flowers. According to the above findings and our results, it could be concluded that, tuberose is an ethylene non-sensitive flower and so it is non-climacteric, because otherwise its vase life should be enhanced with the use of STS and/or $AgNO_3$. Similar situations regarding anti-ethylene functions of STS and $AgNO_3$ have been reported in *Strelitzia* (Finger *et al*. 1999), *Gladiolus* (Mor *et al*. 1981) and *Sandersonia* (Eason and De Vre 1995).

2% sucrose in DDW most extended tuberose cut flower vase-life (15 days) compared with the other treatments (**Table 2**). Carbohydrates are important resources of energy in plant tissues and these compounds, especially sucrose, have considerable effects on cut flower life (Su *et al.* 2001; reviewed in Balas *et al*. 2006; Teixeira da Silva 2006). Liao *et al.* (2000) indicated that pulse sucrose treatment with HQS increased rose cut flowers vase-life. Also, Ichimura and Suto (1999) showed that sucrose reduced sweet pea cut flower sensitivity to ethylene. Reid (1996) also reported that freshly-cut tuberose spikes placed in a preservative vase solution containing 2% sucrose and 8-HQS increased florets

Table 1 The effect of different citric acid and $AgNO_3$ concentrations on the tuberose cut flower vase life (day).

Treatment (mg/l)	Vase life (days)
*Citric acid (0)	5 a
*Citric acid (150)	4.6 ab
*Citric acid (300)	4.4 b
*Citric acid (450)	5.11 a
**$AgNO_3$ (0)	5.2 a
**$AgNO_3$ (50)	3.88 b
**$AgNO_3$ (100)	4 b

Means with similar letters in each column are not significantly different according to Duncan's Multiple Range Test ($P < 0.05$*, $P < 0.01$**).

Table 2 The effect of different sucrose concentrations prepared in 3 kinds of water on tuberose cut flower vase-life (day)* .

Sucrose concentration (%)	Water kind		
	Hamedan tap water	Hamedan cool boiled water	Double distilled water
0	4.67 cd	4.33 d	6 c
2	5 cd	4 d	15 a
4	5 cd	4 d	4.33 d
8	4 d	4 d	7.66 b

*Means with similar letters in each column are not significantly different according to Duncan's Multiple Range Test ($P < 0.01$).

opening and vase-life over 30%. This combination can thus extend tuberose cut flower vase-life in home conditions. Stem re-cutting and changing of the vase solution can increase the effect of this combination.

REFERENCES

Alvarez VN, Colinas-L MT, Villanue-Va VC (1994) Postharvest uses of chemical compounds to increase vase life of cut tuberose flowers. *Serie Horticulture* **1**, 15-20

Anjum MA, Naveed F, Shakeel F, Amin Sh (2001) Effect of some chemicals on keeping quality and vase life of tuberose (*Polianthes tuberosa* L.) cut flowers. *Journal of Research (Science), Bahauddin Zakariya University, Multan, Pakistan* **12 (1)**, 1-7

Balas J, Coronado PAG, Teixeira da Silva JA, Jayatilleke MP (2006) Supporting post-harvest performance of cut-flowers using fresh-flower-refreshments and other vase-water-additives. In: Teixeira da Silva JA (Ed) *Floriculture, Ornamental and Plant Biotechnology: Advances and Topical Issues* (1st Edn, Vol IV), Global Science Books, Isleworth, UK, pp 612-629

Bieleski RL (1977) Accumulation of sorbitol and glucose by leaf slices of Rosaceae. *Australian Journal of Plant Physiology* **4**, 11-24

De Hertogh AA, Le Nard M (1993) *The Physiology of Flower Bulbs*, Elsevier Science Pub. The Netherlands, 812 pp

Dilley DR, Carpenter WJ (1975) The role of chemical adjuvants and ethylene synthesis on cut flower longevity. *Acta Horticulturae* **41**, 117-132

Doss RP (1986) Preliminary examination of some factors that influence the vase life of cut bulb flowers. *Acta Horticulturae* **177**, 655-662

Eason JR, De Vre L (1995) Ethylene insensitive floral senescence in *Sandersonia aurantica*. *New Zealand Journal of Crop and Horticultural Science* **3**, 447-454

Finger FL, Campanha MM, Barbosa JG, Fontes PR (1999) Influence of ethephon, silver thiosulphate and sucrose pulsing on Bird of Paradise vase life. *Revista Brasileira da Fisiologia Vegetal* **11**, 119-122

Goszczynska DM (1989) Postharvest studies with daffodil flowers. *Prace Instytutu Sadownichwa Kwiaciarstwa Skierniewicach* **14**, 147-154

Halevy AH, Kofranek AM (1997) Silver treatment of carnation flowers for reducing ethylene damage and extending longevity. *Journal of the American Society for Horticultural Science* **102**, 76-77

Halevy AH, Mayak S (1981) Senescence and postharvest physiology of cut flowers. *Horticultural Review, Part II* **3**, 59-143

Han SS (1998) Postharvest handling of cut *Heuchera sanguinea* Engelm. flowers: Effects of sucrose and silver thiosulfate. *HortScience* **33**, 731-733

Ichimura K (1998) Improvement of postharvest life in several cut flowers by the addition of sucrose. *Japanese Agricultural Research Quarterly (JARQ)* **32**, 275-280

Ichimura K, Hiraya T (1999) Effect of silver thiosulfate complex (STS) in combination with sucrose on the vase life of cut sweet pea flowers. *Journal of the Japanese Society for Horticultural Science* **68**, 23-27

Ichimura K, Suto K (1999) Effects of the time of sucrose treatment on vase life, soluble carbohydrate concentrations and ethylene production in cut sweet pea flowers. *Plant Growth Regulation* **28**, 117-122

Jones RB, Hill M (1993) The effect of germicides on the longevity of cut flowers. *Horticultural Review, Part II* **3**, 39-143

Jowkar MM, Salehi H (2005) Effects of different preservative solutions on the vase life of cut tuberose flowers at usual home conditions. *Acta Horticulturae* **669**, 411-415

Knee M (1992) Sensitivity of ATPases to silver ions suggests that silver acts outside the plasma membrane to block ethylene action. *Phytochemistry* **31**, 1093-1096

Kofranek AM (1985) Postharvest physiology of cut flowers. In: Singh SP (Ed) *Short Season Flowering Plants*, BR Publishers, New Delhi, India, pp 239-252

Liao LJ, Lin YH, Huang KL, Chen WS, Cheng YM (2000) Postharvest life of cut rose flowers as affected by silver thiosulfate and sucrose. *Botanical Bulletin of Academia Sinica* **41**, 299-303

Meir S, Philosoph-Hadas S, Michaeli R, Davidson H (1995) Improvement of the keeping quality of mini-gladiolus spikes during prolonged storage by sucrose pulsing and modified atmosphere packaging. *Acta Horticulturae* **405**, 335-342

Mor Y, Hardenburg RE, Kofranek AM, Reid MS (1981) Effect of silver thiosulphate pretreatment on vase life of cut standard carnations, spray carnations and gladiolus after a transcontinental truck shipment. *HortScience* **16**, 766-768

Nowak J, Rudnicki RM (1990) *Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants*, Timber Press, Oregon, USA, 210 pp

Parups EV, Peterson EA (1973) Inhibition of ethylene production in plant tissue by 8-Hydroxyquinoline. *Canadian Journal of Plant Science* **53**, 351-353

Reid M (1996) Postharvest handling recommendations for cut Tuberose. *Perishables Handling Newsletter Issue* **88**, 21-22

Saini RS, Yamdaqni R, Sharma SK (1994) Effect of some chemicals on the vase-life of tuberose (*Polianthes tuberosa* L.) cv. Single. *South Indian Horticulture* **42**, 376-378

Salunkhe DK, Bhat NR, Desai BB (1989) *Postharvest Biotechnology of Cut Flowers and Ornamental Plants*, University of California 192 pp

Su WR, Huang KL, Chang PS, Chen WS (2001) Improvement of postharvest vase life and flower bud opening in *Polianthes tuberosa* using gibberellic acid and sucrose. *Australian Journal of Experimental Agriculture* **41**, 1227-1230

Teixeira da Silva JA (2006) Ornamental cut flowers: physiology in practice. In: Teixeira da Silva JA (Ed) *Floriculture, Ornamental and Plant Biotechnology: Advances and Topical Issues* (1st Edn, Vol I), Global Science Books, Isleworth, UK, pp 124-140