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EFFECT OF FLORAL PRESERVATIVES ON POST HARVEST LIFE AND QUALITY OF CUT SPIKES OF GLADIOLUS (*GLADIOLUS GRANDIFLORUS* L.)

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ABSTRACT

The investigation was carried out with gladiolus cv. Candyman during February 2016 to assess the effect of chemical floral preservatives on gladiolus in terms of vase life and flower quality. The experiment comprised of 3 chemical preservatives, silver nitrate (25 mg l^{-1} and 50 mg l^{-1}), sucrose (2.5 % and 5 %), calcium carbonate (2 % and 4 %) and distilled water as control. Among the various preservative solutions used, T_4 (5% sucrose) significantly increases fresh weight of spike on 6th day (61.12 g) and 9th day (49.66 g); water uptake (121.96 ml), opened florets (92.33 %), increase in spike length (7.70 cm), diameter of third fully opened florets (11.60 cm) and total soluble solids (7.20 º Brix). Similarly the use of 5 % sucrose solution drastically decreases water loss (153.90 ml), water loss/uptake (1.26), days taken to basal floret open (2.55), number of unopened florets at senescence (1.66) and electrolyte leakage (30.78 %). Preservative 2 % $CaCO_3$ recorded maximum diameter of first fully opened florets (11.67 cm) and chlorophyll content of petals (72.07 mg/g). From the present investigation, it can be concluded that holding spikes in 5 % sucrose solution improved spike length, number of opened florets, diameter of florets and extended vase life by eleven days in gladiolus cv. Candyman.

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INTRODUCTION

Gladiolus, the queen of bulbous flowers, belongs to the family Iridaceae, is considered to be a high value flower crop. Internationally it is known for its dazzling florets colour, sturdy spike, size and attractive appearance and keeping quality and occupies fifth position in the international trade. In Chhattisgarh it is cultivated in 1660 ha. area with 5182 Ton production (Anonymous, 2016). The domestic consumption of cut flowers has increased significantly but the longevity is one of the main challenges of florists today. The longevity of gladiolus cut flowers is very short. The typical vase life of individual florets is just 4 to 5 days (Kumar *et al.,* 2016). Several preservatives *i.e.* silver nitrate, silver thiosulphate, sucrose, calcium chloride, 8-HQC etc. have been used in different concentrations and combinations to enhance vase life of gladiolus (De *et al.,* 1996; Suneetha and Kumar, 1998; Kumar, 2005; Singh *et al.,* 2008; Beniwal *et al.,* 2011).

Floral preservatives inhibits the synthesis of ethylene after cutting the spike and an ideal floral preservative should contain sucrose as energy source with germicidal effect, which ultimately improves vascular system for longer survival of spike during post harvest (Bharathi and Barman, 2015). Carbohydrates are the main source of flowers nutrition and the source of energy for biochemical and physiological processes after separation from the mother plant (Keshavarzi and Chamani, 2011). The common carbohydrate used in the vase solution is sucrose. Sucrose provides the required energy for metabolic activity of cells such as maintaining the structure and function of mitochondria and other organelles. In addition, sucrose facilitates transport of water and minerals inside the xylem by controlling transpiration (Capdeville *et al.*, 2003). The vase life of cut flower is influenced by constant water supply, checking of microbial growth prevention from ethylene formation and energy source. Continuous treatments with glucose at 2.5 or 5% (with isothiazolinonic germicide and aluminium sulfate) significantly extended the vase life of cut dahlia flowers and the relative fresh weight (Takahashi *et al.,* 2016). Whereas, silver ions strongly inhibit microbial activities because of the high surface and volume of these particles (Furno *et al.,* 2004). Increased calcium uptake reduces the invasion of cell wall by fungal pathogens and deficiency of calcium results in topple disorder by which spikes break down when kept in vase (Misra and Singh, 1993).

The specific foreign trade standards cannot be obtained unless suitable post harvest management techniques in gladiolus are developed in the region (Sharma *et al.,* 2013). Hence the post harvest pulsing for quality spike production need to be developed and standardized. In the present study, an attempt has been made for selection of suitable floral preservative at proper concentration under Chhattisgarh plains condition for long distance transport of spikes to metro cities and export of recommended variety "Candyman".

MATERIALS AND METHODS

The present study was conducted at the Department of Floriculture and Landscape Architecture, College of Agriculture, IGKV, Raipur (C.G.) during the year 2015-16. The crop was raised under standard uniform cultural conditions planted in November 2015 and harvested in February 2016. The spikes were harvested early in the morning when lower most 1- 2 florets started showing colour and were brought to the laboratory immediately by placing them in bucket containing water. The maximum and minimum laboratory temperatures fluctuated between 26-29ºC and 14-21ºC, respectively, and relative humidity was 62-78 % during the course of investigation. The basal 2 cm portion of the uniform size spike was re-cut in water to expose fresh tissue and the spikes were put in vase solutions containing different chemicals and compared with control (Beniwal *et al*., 2011). Experiment was laid in completely randomized design (CRD) consisting of seven treatments viz., T_1– $AgNO_3$ 25 mg l^{-1}, T_2– $AgNO_3$ 50 mg l^{-1}, T_3– Sucrose 2.5 %, T_4–Sucrose 5 %, T_5– $CaCO_3$ 2 %, T_6– $CaCO_3$ 4 % and T_7 – distilled water (control) and were replicated three times. Observations were recorded on fresh weight of cut spike at 3, 6, and 9 DAT. Water uptake (ml), water loss (ml), loss/uptake ratio, opened florets (%), increase in spike length (cm) were determined 10 DAT. Diameter of first, third and last fully opened florets (cm), days taken to open basal floret, days to wither first pair of florets, number of unopened florets at senescence and vase life were recorded daily. Total soluble solids in petals, chlorophyll content, bacterial count and electrolyte leakage were estimated 8 DAT. Solution uptake (ml) was measured by the total quantity of water in aqueous solution used by the spike up to wilting of last opened floret. Vase life (days) was recorded in terms of duration between the opening of first basal floret and wilting of sixth floret from the base of spike was taken as actual vase life and presented in days (Suneetha and Kumar, 1998). Total soluble solids in the petal tissue was determined as per the method of Franscistt *et al*. (1971). Chlorophyll content was estimated using SPAD-502 Plus (Japan). Bacterial colonies were counted with the method suggested by Van Meeteren *et al*. (2000). Electrolyte leakage (ion leakage) of the petal tissue was determined according to the earlier method (Singh *et al*., 2008). The statistical analysis was done by adopting the appropriate standard error (S.E.m ±) method in each case as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Spikes kept in different floral preservative at different concentrations showed significant difference. Among all the treatments, maximum fresh weight of spike at 6 days and 9 days was observed in treatment T_4 (Sucrose 5%) which was at par with T_2 ($AgNO_3$ 50 mg l^{-1}) whereas minimum fresh weight was observed in T_7 (control). It might be due to the fact that sucrose facilitated the higher intake of water and total soluble sugars in the petal cells probably by enhancing the osmotic driving force for the solution uptake by making the cells water potential more negative. The increase in solution uptake in the cut spikes further caused increase in spike weight. De Silva *et al*. (1982) opined that addition of sucrose to the solution increased the mechanical rigidity of the stem inducing cell wall thickening and lignifications of vascular tissues. Whereas, the germicidal properties of $AgNO_3$ in addition to inhibition of ethylene biosynthesis which resulted in gain in fresh weight. The present results are in close conformity with the findings of De *et al*. (1996); Beniwal *et al*. (2011) in gladiolus and Takahashi *et al*. (2016) in gerbera.

Significantly maximum water uptake with minimum loss/uptake ratio of water was recorded in T_4 (Sucrose 5%) while the minimum water uptake and maximum loss/uptake ratio was reported in control. However, significantly minimum water loss was observed in T_5 ($CaCO_3$ 2 %). T_4 ants invaded due to sugar contents taking a significant amount of water and this has also been counted towards water uptake. Sucrose improves water absorption from the vase solution which made a better water balance by maintaining turgidity and flower freshness and saves from early wilting resulting in enhanced vase life. This result is in agreement with the findings of Kumar (2005); Beniwal *et al*. (2011) in gladiolus and Bharathi and Barman (2015) in cymbidium orchid. Least water loss in T_5 might be attributed to the action of calcium which leads to decrease the respiration rate, osmotic adjustment and stability of cell membrane (Poovaiah and Leopold, 1973).

Results revealed that opened florets percentage increases with increase in sucrose and silver nitrate concentration. The

Table 1: Effect of floral preservatives on post harvest parameters of gladiolus cut spikes

Treatments	Fresh weight of cut spike (g)			Water uptake (ml)	Water loss (ml)	Loss/ uptake ratio	Opened florets (%)	Increase in spike length	Diameter of first fully opened florets (cm)	Diameter of third fully opened florets (cm)	Diameter of last fully opened florets (cm)
	3 day	6 days	9 days								
T_1 ($AgNO_3$ 25 mg l^{-1})	66.50	51.03	40.27	107.86	153.07	1.42	87.07	6.43	9.67	9.53	8.77
T_2 ($AgNO_3$ 50 mg l^{-1})	66.44	57.97	45.25	108.90	154.11	1.42	88.13	7.23	10.17	11.07	8.73
T_3 (Sucrose 2.5 %)	66.24	56.62	44.55	120.78	160.25	1.33	90.27	7.07	10.63	10.97	8.87
T_4 (Sucrose 5 %)	66.48	61.12	49.66	121.96	153.90	1.26	92.33	7.70	10.77	11.60	9.07
T_5 ($CaCO_3$ 2 %)	65.98	47.69	37.36	100.45	138.38	1.38	84.60	5.47	11.67	10.47	8.20
T_6 ($CaCO_3$ 4 %)	66.55	50.62	39.39	101.57	147.82	1.46	87.93	5.93	11.10	11.17	8.43
T_7 (Distilled water)	65.11	37.99	25.51	94.92	144.46	1.52	75.20	3.10	11.27	9.30	7.87
SE (m) ±	3.93	5.02	5.54	1.89	3.77	0.04	2.60	0.69	1.32	1.43	1.04
C.D. (0.05)	NS	4.46	4.92	1.67	3.34	0.03	2.31	0.61	1.18	1.27	NS
C.V. (%)	-	4.84	6.88	0.87	1.25	1.34	1.50	5.59	6.51	6.75	-

Table 2: Effect of floral preservatives on post harvest quality of gladiolus cut spikes

Treatments	Days taken to open basal floret	Days to wither first pair of florets	No. of unopened florets at senescence	Vase life	Total soluble solids in petals (°Brix)	Chlorophyll content (SPAD reading)	Bacterial count (Log_{10} CFU mg^{-1}) Vase solution	Stem end	Electrolyte leakage (%)
T_1 ($AgNO_3$ 25 mg l^{-1})	3.44	5.55	2.33	10.11	5.70	64.07	24.00	12.33	35.46
T_2 ($AgNO_3$ 50 mg l^{-1})	2.77	5.77	2.00	10.66	5.87	61.30	18.33	7.67	35.49
T_3 (Sucrose 2.5 %)	3.00	6.00	2.11	10.55	6.97	57.33	83.67	49.33	36.59
T_4 (Sucrose 5 %)	2.55	6.22	1.66	11.00	7.20	62.00	90.33	54.33	30.78
T_5 ($CaCO_3$ 2 %)	3.55	4.89	2.88	8.77	5.10	72.07	16.67	15.00	33.63
T_6 ($CaCO_3$ 4 %)	3.44	5.11	2.89	8.88	4.93	62.13	29.67	13.67	31.93
T_7 (Distilled water)	4.44	4.44	4.22	7.33	4.50	64.17	71.00	44.67	43.63
SE (m) ±	0.66	0.55	0.56	0.43	0.40	12.68	8.60	5.92	2.96
C.D. (0.05)	0.59	0.48	0.49	0.38	0.36	11.26	7.64	5.26	2.63
C.V. (%)	10.02	5.03	10.77	2.23	3.48	10.01	9.02	10.52	4.19

maximum opened florets were reported in T_4 (sucrose 5%) which was at par with T_3 (sucrose 2.5%). It might be due to the supply of optimum level of energy at cut end of spikes which improved water uptake of the spikes and accelerated florets opening (De *et al.,* 1996). Maximum increase in spike length was recorded with treatment of 5 % sucrose (T_4) closely followed by $AgNO_3$ 50 mg l^{-1}(T_2) whereas least increase in spike length was reported in control. However, all floral preservative effects were recorded to be better result over control. This effect was enhanced by addition of sucrose as increase in spike length is a growth process and sucrose acts as respiratory substrate and enhancer of water uptake. Correlation between vase life and increase in spike length was reported during experiment. These findings are in close agreement with Jature *et al.* (2009) in tuberose.

Diameter of florets was significantly influenced by floral preservatives. The maximum diameter of first fully opened florets was observed in T_5 ($CaCO_3$ 2%) followed by T_7, T_6, T_4 and T_3 (Table 1). Whereas, diameter of third fully opened florets was increased in treatments with sucrose or calcium carbonate and found maximum in T_4, while minimum in control. Diameter of last fully opened florets was found non-significant to floral preservatives. The increase in floret size by various floral preservatives might be due to the fact that sucrose provides energy for growth while calcium has profound effect to check deleterious microbial effect (Farnham *et al.*, 1972). Similar results were reported by Kumar (2005) in gladiolus and Jature *et al.* (2011) in tuberose.

An inquisition of data presented in Table 2 revealed that minimum days taken to basal floret opening was observed in T_4 which was at par with T_3 and T_2 whereas maximum days in control. It may be due to the exogenous supply of sucrose which replaced the depleted endogenous carbohydrate, utilized during the vase life of flower and thereby enhanced vase life (Kumar, 2005). The increase in floret opening and longevity by mineral salts (silver nitrate) might be due to the fact that mineral salts increase the osmotic concentration and pressure potential of the petal cells, thus improving the water balance and quality of cut spikes (Halevy, 1976). The finding is in accordance with the results of Beniwal *et al.* (2011) in gladiolus and Takahashi *et al.* (2016) in dahlia.

T_4 also recorded the maximum days to wither first pair of florets which was found to be at par with T_3 and T_2. The increase days to wither first pair of florets in sucrose treatments is attributed to the fact that it enhances the effect of cytokinins in delaying senescence of flowers and reduces the effect of ethylene in promoting senescence (Mayak and Delley, 1976). Earlier workers (Borochov *et al.*, 1976) have demonstrated that sucrose antagonized the effect of abscisic acid in promoting the senescence of roses. The significantly lowest number of unopened florets at senescence was recorded in T_4, T_3 and T_2, respectively, but all three of these were statistically at par. The control recorded significantly highest value for number of unopened florets at senescence. The enhanced number of open florets per spike might be due to sucrose and higher solution uptake. That's why higher petal sugar status and water balance in flowers is suggested to improve bud opening (Halevy and Mayak, 1981). These results are in accordance with the results of Kumar (2005) in gladiolus.

The results (Table 2) showed that floral preservatives significantly effects quality and vase life of cut spikes. The highest vase life was recorded in T_4 (Sucrose 5%) which was significantly higher than all other treatments except T_2 ($AgNO_3$ 50 mg l^{-1}) while the lowest was recorded in control. Increase in vase life with sucrose might be due to its action as a food source and a respiratory substrate, which helps delay the degradation of proteins and improves the water balance of cut flowers (De Silva *et al.,* 2013).

However, dilute solution of sucrose provided ideal media for microbial growth. Silver nitrate might have decreased microbial growth and prevented vascular blockage, thereby helped in increasing vase life and improving turgidity and other spike characteristics recorded in the present investigation. Similar results had been recorded by several workers (Suneetha and Kumar, 1998; Singh *et al.,* 2008; Jature *et al.,* 2009; Beniwal, *et al.,* 2011). Likewise, among the treatments, significantly highest total soluble solids was obtained in T_4. This may be attributed to the fact that the accumulation of soluble sugars in petals was more in treatment receiving sucrose; it is presumed that some of the dry matter might have moved from leaves to petals (Ho and Nicholas, 1977).

Maximum chlorophyll content (SPAD value) of petals was obtained in T_5 ($CaCO_3$ 2 %) followed by T_1, T_7, T_6 and T_4. Sucrose 2.5% reported minimum chlorophyll content. The exogenous application of calcium improves and maintains

chlorophyll and proteins content, hence delay senescence. Moreover, the application of calcium leads to maintenance of cell integrity, reduction in free spaces of leaf tissues and encourages water saving that all occur during senescence (Poovaiah and Leopold, 1973).

Bacterial colony count was reported minimum in T_5 vase solution which was at par with T_2 while maximum in T_4 (Table 2). However, the minimum bacterial colony count in cut end of spike was observed in T_2 followed by T_1 and T_6. Hence silver nitrate and calcium chloride significantly suppress the microbial growth. Germicide like calcium carbonate in vase water can prevent the growth of microbes and increased water uptake (Farnham *et al*., 1972). Rai *et al*. (2009) reported that silver particles show efficient antimicrobial properties due to large surface area, which provide better contact with microbes. Furno *et al*. (2004) showed in cut rose that the bacterial concentration in the stem ends of control was significantly higher than in flower treated with SNP (Silver nano particles).

The results showed that minimum electrolyte leakage was in T_4 which was at par with T_6. This might be due to the fact that leakage of ions is known to coincide with the decrease in water content of the flower petals and senescence (Singh *et al*., 2008). Sucrose improves water absorption from the vase solution which made a better water balance by maintaining turgidity and can also maintain membrane stability (Barathi and Barman, 2015). Sucrose can regulate gladiolus floret senescence not only through its effect on ethylene action, but also by other mechanisms including maintaining membrane stability and increasing the antioxidant enzyme activity. Whereas, calcium plays a crucial role in plant membrane stability, cell wall stabilization, and cell integrity (Hirschi, 2004).

Floral preservatives in gladiolus cut spikes influenced the post harvest life and quality of the flower. Among the treatments, use of 5 % sucrose as holding solution significantly increased the vase life and flower quality of cut spikes of gladiolus cv. 'Candyman'.

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