



Effect of Polyamines on Post Harvest Physiology and Vase Life of Cut Gerbera

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted at College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad. Significantly highest relative water content (74.22%) and carotenoid content (5.58 mg) were recorded in spermine 1.0 mM compared to spermidine 1.5 mM and putrescine 3.0 mM. The impact of spermine in increasing the petal carotenoid content might be delaying carotenoid degradation via their enzymatic oxidation in the chromoplasts and prevent the breakdown of flavonoids to make the flower fresh by improving water absorption. An increase in membrane stability index (55.87%) as indicated by ion leakage was found to be delayed or reduced (25.93%) by the use of spermine 1 mM. While the control was at highest (38.58%) and prolonged flower longevity compared with untreated flowers. Spermine 1.0 mM was found to be more effective in maintaining higher levels of TSS (10.37o Brix) and soluble sugars are involved in membrane stability and reduce the flower wilting. Thus, the treatments of spermine @ 1.0 mM ppm influenced the postharvest physiology of gerbera flowers and extended the vase life of gerbera by 4-5 days as compared to control.

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1. INTRODUCTION

Gerbera is a well known cut flower crop of the world due to the attractive daisy shape of flowers. This highly decorative flower plant is currently fifth most popular cut flower in the world. Due to its high vase life this plant has become very popular as a cut flower and is now widely cultivated. The *gerbera* belongs to the Asteraceae or daisy/sunflower family. It is a tender perennial herb, also known as African daisy, Transvaal daisy or Barberton daisy. The large flower heads of these daisies have ray-like petals around a center disk of tiny green or black flowers. There are four different classes of *Gerbera* daisies: single flower, semi-double flower, double flower, and spider flower. Each class delineates the number, position, and type of petals. The leaves of the plant are lobed or pinnate and often toothed.

Gerbera is an herbaceous perennial herb and it has a very good export potential because of its graceful appearance, hardiness & long shelf life during transportation. According to global trends in floriculture, it occupies the 4th place among cut flowers. It is used in floral arrangements, flower beds, borders, pots and rock gardens. Besides floral arrangements, *gerbera* is widely used in bouquets and in dry flower crafts. It is in considerable demand in both domestic and export market. Besides, the problem with *gerbera* cut flowers is the short postharvest life. Vase life is often used as an indicator of postharvest longevity in cut flowers, and is determined by the number of days from harvest until flower senescence.

Postharvest life is an important parameter determining the marketability of cut flower as they are generally highly perishable. Nearly, 30-50 per cent losses of cut flowers occur due to improper postharvest handling during entire market chain [1]. The vase life of *gerbera* is limited due to petal wilting, premature senescence, stem plugging, stem breaking and scape bending. Few scientists have worked on postharvest technology in *gerbera* using polyamines.

Polyamines (PAs) are small aliphatic amines that are ubiquitous in all plant cells and known for their anti-senescence effects during ageing sequence of plant tissue by retarding ethylene synthesis by inhibiting ACC synthesis. PAs showed positive effects on postharvest quality and vase life of cut *gerbera* due to their impacts

on ROS and antioxidant capacity. Polyamines viz., spermine, spermidine and putrescine are a new class of aliphatic amines, seem to be more effective in preventing senescence-related events in plants and improve the keeping quality of cut flowers. Hence, this experiment was intended to study the influence of polyamines (spermine, spermidine and putrescine) on postharvest physiology of *gerbera* with the basic objective to extend its vase life.

2. MATERIALS AND METHODS

The experiment was conducted at Department of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad during 2016-17. The experiment was arranged in completely randomized design with three replications. The required number of conical flasks were washed, weighed, and labelled as per the schedule of treatments. Similarly, a calculated quantity of each Polyamines, viz., spermine, spermidine and putrescine were weighed and then dissolved in the required quantity of distilled water to make the required concentration as per the technical programme.

Gerbera cut spikes were collected from the plants grown under the poly house of Horticulture Garden. *Gerbera* flowers of the variety 'Goliath' were harvested when all the florets opened fully and were perpendicular to the stalk. The flowers were harvested early in the morning by cutting the stalk with sharp secateurs having the stalk length of above 50 to 60 cm from the flower head. Flowers were kept in water immediately after harvest. The flower stalks are given slant cut to provide more solution accumulated area and remove any surface embolism. The cut flowers were precooled at 4±2°C for about 4 hours and then immediately unpacked, sorted to uniform length and quality of capitulum. Recutting the base before placing them in different polyamine solution are essential for extension of vase life of cut flowers. The flowers were sorted out for uniform flower size so as to maintain uniformity with in the replication. Stems were then cut to a uniform length of 45 cm, then each flower stalk was placed in 600 ml bottle containing 500 ml of aqueous solutions of different polyamines were used individually or in combinations as described separately in each experiment.

The weight of each container and the test solution with and without flower scapes were recorded once in two days, while recording weights recutting of the floral stems (about 0.5 cm) was done under water. The flowers were continuously held in the treatment solutions till the end of the vase life period. Observations were recorded for Relative water content, Total soluble solids, Carotenoids, Electrolyte leakage and Membrane stability index

3. RESULTS AND DISCUSSION

3.1 Relative Water Content (RWC%)

Higher RWC was maintained in gerbera cut flowers placed in spermine 1.0 mM (74.22%) followed by spermidine 1.5 mM (72.09%) and putrescine 3.0 mM (70.42%). While RWC was affected by various polyamine treatments where in control (50.56%) cut flowers had significantly lower relative water content during experiment, significantly highest hydration level in the petals was found with spermine 1.0 mM on day 3, 6 and 9 (81.27%, 73.92% and 67.46% respectively) which were on par with spermidine 1.5 mM (79.22%, 71.67% and 65.37 %). The lowest RWC was however, noted with the treatment T₁₃ on day 3, 6, and 9 (64.58, 50.62 and 36.48) which were on par with spermidine 3.0 mM (65.17%, 52.41% and 42.49%) and putrescine 3.0 mM (77.38%, 69.95% and 63.94%) on day 3, 6 and 9.

Liu et al. [2] and Yamaguhi et al. [3] proposed a model describing a role of polyamines during drought stress, which is correlated with cut flowers senescence. Polyamines may modulate the activities of certain ion channels, especially Ca²⁺ permeable channels and raise cytoplasmic Ca²⁺ concentration. This event is known to inactivate the K⁺ inward rectifier at the plasma membrane, which could stimulate stomatal closure. As a consequence of polyamines causes decrease in transpiration and may increase relative water content. Similar effects of improving relative water content with spermine reported by Rubinowska et al. [4] in cut roses.

3.2 Total Soluble Solids (°Brix)

Highest TSS with spermine 1.0 mM (10.37 °Brix) followed by spermidine 1.5 mM (10.13° Brix) and putrescine 3.0 mM (9.88° Brix). While control was recorded lowest TSS (.7.26° Brix). The TSS initially increased from day 3 (10.08 °Brix) to day 9 (7.65 °Brix) and thereafter decreased towards

end of the vase period. On day 3, highest TSS (11.53 °Brix) which was on a par with spermidine 1.5 mM (11.25 °Brix) and putrescine 3.0 mM (10.96° Brix) whereas the lowest TSS (8.65°Brix) was recorded in control. On day 6 and 9 also, similar trend was observed with highest TSS recorded by flowers held in spermine 1mM (10.34 and 9.24° Brix) followed by spermidine 1.5 mM (10.13 and 9.00° Brix) and putrescine 3.0 mM (9.93 and 8.76° Brix). While control recorded lowest TSS (7.42 and 5.72° Brix) on day 6 and 9 respectively.

Highly retained fresh weight might have restricted the degradation of macro molecules viz., starch, proteins, nucleic acid, lipids and stimulate their synthesis in the petal cells and thus contributed to maintained higher levels of TSS. Soluble sugars are involved in membrane stability and reduce the flower wilting [5]. Similar findings observed in roses treated with 10 ppm spermine showed maximum TSS reported by Sumathi Tatte et al. [6], Palagani and Singh [7] and Mohammadi, et al. [8].

3.3 Carotenoids (mg / g f wt)

According to results shown in Table 3 carotenoid content was decreased progressively during experiment of cut gerbera. Highest carotenoid content was recorded in gerbera cut flowers with spermine 1.0 mM (5.58 mg) followed by spermidine 1.5 mM (5.49 mg) and putrescine 3.0 mM (5.42 mg). Highest carotenoid content was recorded in gerbera cut flowers with spermine 1.0 mM from 3rd day (6.21 mg) to 9th day (4.86 mg) which was on a par with spermidine 1.5 mM (4.77 mg) and putrescine 3.0 mM (4.72 mg). However, control recorded lowest carotenoid content (3.84 mg). Polyamines are more appropriate to keep the petal pigments. The impact of spermine in increasing the petal carotenoid content might be delaying carotenoid degradation via their enzymatic oxidation in the chromoplasts and prevent the breakdown of flavonoids to make the flower fresh by improving water absorption. Similar findings reported by Rubinowska et al. [4] in cut rose.

3.4 Electrolyte Leakage (EL) (%)

The flower scapes treated with spermine 1.0 mM recorded significantly lowest EL (25.93%), however highest EL was registered in control (33.69%) followed by spermidine 3.0 mM (30.46) and spermine 2.0 mM (29.71). Similarly, EL in the petal tissue of gerbera flowers held in

spermine 1.0 mM (23.27, 26.18 and 28.35 %) followed by spermidine 1.5 mM (23.58, 26.47 and 28.67 %) and putrescine 3.0 mM (23.91, 26.94 and 29.15%) recorded on 3rd, 6th and 9th day respectively was much lower than control (27.73, 33.58 and 39.75%) as recorded on 3rd, 6th and 9th day of vase life.

The electrolyte leakage showed increasing trend from day 3 (25.17) and day 9 (31.54). This might be due to senescence accompanied by dramatic increase in electrolyte leakage of many molecules including pigments, amino acid, sugars, K⁺ and total electrolytes. The leakage of ions is known to coincide with the decrease in water content of the flower petals and

senescence had indicated free radical scavenging effect of polyamines that reduce electrolyte leakage. The present result in accordance with the findings reported by Sumathi et al. [6] in cut roses and in gladiolus observed by Dantuluri et al. [9].

3.5 Membrane Stability Index (%)

Greater Membrane stability index is recorded in spermine 1.0 mM (55.87%) followed by spermidine 1.5 mM (54.49 %) and putrescine 3.0 mM (53.12%). Whereas control however recorded lowest MSI (38.58%). MSI in the flower tissue treated with spermine 1.0 mM

Table 1. Effect of polyamines on relative water content (%) of cut gerbera

Treatments	RWC (%)			Mean
	3 rd day	6 th day	9 th day	
T ₁	70.35	61.37	56.37	62.70
T ₂	81.27	73.92	67.46	74.22
T ₃	69.00	57.62	52.71	59.78
T ₄	66.28	53.43	46.52	55.41
T ₅	72.74	63.74	58.84	65.11
T ₆	79.22	71.67	65.37	72.09
T ₇	75.63	67.53	62.58	68.58
T ₈	65.17	52.41	42.49	53.36
T ₉	68.73	59.14	54.53	60.80
T ₁₀	74.11	65.84	60.32	66.76
T ₁₁	77.38	69.95	63.94	70.42
T ₁₂	68.67	55.35	49.61	57.88
T ₁₃	64.58	50.62	36.48	50.56
Mean	71.78	61.74	55.17	
SEm ±	1.84	1.64	0.73	
CD@ 5%	5.38	4.79	2.19	

Table 2. Effect of polyamines on TSS (⁰Brix) of cut gerbera

Treatments	Total soluble solids (⁰ Brix)			Mean
	3 rd day	6 th day	9 th day	
T ₁	10.00	8.91	7.73	8.88
T ₂	11.53	10.34	9.24	10.37
T ₃	9.73	8.51	7.15	8.46
T ₄	9.25	7.90	6.62	7.92
T ₅	10.24	9.15	7.94	9.11
T ₆	11.25	10.13	9.00	10.13
T ₇	10.72	9.76	8.53	9.67
T ₈	8.83	7.73	6.21	7.59
T ₉	9.95	8.75	7.43	8.71
T ₁₀	10.53	9.37	8.28	9.39
T ₁₁	10.96	9.93	8.76	9.88
T ₁₂	9.43	8.34	6.83	8.20
T ₁₃	8.65	7.42	5.72	7.26
Mean	10.08	8.94	7.65	
SEm ±	0.38	0.33	0.24	
CD@ 5%	1.11	0.97	0.72	

(68.34, 56.91 and 42.36%) recorded more followed by spermidine 1.5 mM (66.95, 55.34 and 41.18%) and putrescine 3.0 mM (65.17, 54.26 and 39.24 %) on 3rd, 6th and 9th day respectively was much higher than control (51.48, 41.85 and 22.42 %) on 3rd, 6th, 9th day of vase life.

Membrane stability index declined with onset of senescence. Polyamines greatest contribution to plants in membrane stabilization as free radical

scavengers and rate of ion leakage was four times higher just before wilting. In a research, Dantuluri et al. [9] found that application of spermine on cut gladioli flowers delay aging by increasing the membrane stability. Similar results were obtained in cut roses with spermine and spermidine by Yang et al. [10]. In addition, polyamines are also known to prolong flower longevity by reducing membrane seepage thereby conferring membrane stability [11].

Table 3. Effect of polyamines on carotenoid content (mg / g f wt) of cut gerbera

Treatments	Carotenoid content (mg / g f wt)			Mean
	3 rd day	6 th day	9 th day	
T ₁	5.15	5.37	4.37	4.96
T ₂	6.21	5.67	4.86	5.58
T ₃	5.27	4.85	4.18	4.77
T ₄	5.12	4.63	3.97	4.57
T ₅	5.67	5.41	4.46	5.18
T ₆	6.13	5.58	4.77	5.49
T ₇	5.85	5.49	4.68	5.34
T ₈	5.00	4.48	3.92	4.47
T ₉	5.32	4.96	4.25	4.84
T ₁₀	5.79	5.45	4.52	5.25
T ₁₁	6.00	5.53	4.72	5.42
T ₁₂	5.20	4.74	4.10	4.68
T ₁₃	4.86	4.28	3.84	4.33
Mean	5.33	5.29	4.36	
SEm ±	0.32	0.11	0.19	
CD@ 5%	0.93	0.33	0.55	

Table 4. Effect of polyamines on electrolyte leakage (%) of cut gerbera

Treatments	Electrolyte leakage (%)			Mean
	3 rd day	6 th day	9 th day	
T ₁	25.00	28.37	30.83	28.07
T ₂	23.27	26.18	28.35	25.93
T ₃	25.72	29.00	32.00	28.91
T ₄	26.41	29.79	32.93	29.71
T ₅	24.86	27.96	30.39	27.74
T ₆	23.58	26.47	28.67	26.24
T ₇	24.12	27.28	29.56	26.99
T ₈	26.84	30.10	34.45	30.46
T ₉	25.37	28.64	31.52	28.51
T ₁₀	24.41	27.65	29.91	27.32
T ₁₁	23.91	26.94	29.15	26.67
T ₁₂	26.00	29.41	32.47	29.29
T ₁₃	27.73	33.58	39.75	33.69
Mean	25.17	28.57	31.54	
SEm ±	0.70	0.73	1.02	
CD@ 5%	2.06	2.12	2.98	



Fig. 1. View of laboratory study



Fig. 2. Effect polyamines in holding solution on vase life of cut gerbera cv. Goliath

Table 5. Effect of polyamines on membrane stability index (%) of cut gerbera

Treatments	Membrane Stability Index (%)			Mean
	3 rd day	6 th day	9 th day	
T ₁	59.79	50.64	34.69	48.37
T ₂	68.34	56.91	42.36	55.87
T ₃	57.00	48.00	31.62	45.54
T ₄	55.35	45.83	27.63	42.94
T ₅	61.74	51.67	35.84	49.75
T ₆	66.95	55.34	41.18	54.49
T ₇	63.88	53.63	38.71	52.07
T ₈	54.00	44.57	25.39	41.32
T ₉	58.53	49.25	33.27	47.02
T ₁₀	62.25	52.31	37.25	50.60

Treatments	Membrane Stability Index (%)			Mean
	3 rd day	6 th day	9 th day	
T ₁₁	65.17	54.26	39.94	53.12
T ₁₂	56.15	47.14	29.57	44.29
T ₁₃	51.48	41.85	22.42	38.58
Mean	60.05	50.11	33.84	
SEM ±	1.74	1.72	1.65	
CD @ 5%	5.09	5.04	4.84	

*T*₁–Spermine @ 0.5 mM *T*₈–Spermidine @ 3.0mM
*T*₂–Spermine @ 1.0 mM *T*₉– Putrescine @ 2.0 mM
*T*₃–Spermine @ 1.5 mM *T*₁₀–Putrescine @ 2.5 mM
*T*₄–Spermine @ 2.0 mM *T*₁₁–Putrescine @ 3.0 mM
*T*₅–Spermidine @ 1.0 mM *T*₁₂–Putrescine @ 4.0 mM
*T*₆–Spermidine @ 1.5 mM *T*₁₃–Control
*T*₇–Spermidine @ 2.0 mM

4. CONCLUSION

From the present study, it may conclude that different polyamines had significant impact on vase life quality of cut gerbera. The longest vase life obtained with spermine 1 mM followed by spermidine 1.5 mM. Whereas control recorded short vase life of cut flowers. An increase in membrane stability index (55.87%) as indicated by ion leakage was found to be delayed or reduced by the use of spermine 1mM. While the control was at highest (38.58%) and discoloration or fading of flowers due to poor water relations and early degradation of sugars. Hence, Spermine is more appropriate to keep the petal pigments and extend the vase life period in cut gerbera.

The enhanced vase life of gerbera cut flowers in this treatment can be attributed to increased water uptake, higher retention of fresh weight and high petal sugar status. Further it reduced water stress and stabilized membrane integrity and cellular structure as indicated by higher membrane stability index which ultimately delayed petal senescence and the increase the longevity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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