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Influence of postharvest application of chemicals on postharvest physiology and vase life of gerbera var. Alcatraz

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Abstract
An investigation was carried out to study the effect of polyamines *viz*., spermine, spermidine, putrescine and salicylic acid and α-lipoic acid on postharvest physiology and vase life of gerbera. Chemicals were applied in the form of vase solution @ 10 and 20 ppm each. Among all the treatments, gerbera cut flowers treated with spermine @ 10 ppm showed maximum retention of flower fresh weight (38.01, 38.15, 24.27 and 21.88 g), total soluble sugars (34.95, 38.78, 41.15 and 33.72 mg/g), protein content (23.09, 26.00, 27.26 and 17.29 mg/g) and minimum electrolytic leakage (19.19, 26.26, 33.21 and 43.07 %) in the petal tissue which was at par with salicylic acid @ 20 ppm as recorded on 4th, 8th, 12th and 14th day of vase life. Further, phenols in the petal tissue (3.00, 2.62, 2.42 and 2.08 mg/g) were recorded higher with salicylic acid @ 20 ppm and followed by spermine @ 10 ppm. Anthocyanin content in the petal tissue (17.38 mg/g) and lignin content (6.55 %) in the stalk of gerbera were maximum with the vase solution treatment of spermine @ 10 ppm and followed by salicylic acid @ 20 ppm. Gerbera cut flowers treated with spermine @ 10 ppm showed enhanced vase life (16.92 days), which was at par with salicylic acid @ 20 ppm (16.50 days) as compared to control (12.08 days). Thus, the treatments of spermine @ 10 ppm and salicylic acid @ 20 ppm influenced the postharvest physiology of gerbera flowers and extended the vase life of gerbera by 4-5 days as compared to control.

Keywords: Gerbera, spermine, salicylic acid, fresh weight, phenols, protein, vase life

Introduction
Gerbera (*Gerbera jamesonii* Hook.), a magnificent cut flower belongs to the family Asteraceae and is one among the top five cut flowers in the domestic and global flower trade Zheng *et al*., [32]. 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 Kumar *et al*., [17]. 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 PGRs Emongor, [9], sucrose Banaee *et al*., [4] and antimicrobial agents Sujatha *et al*., [29]. 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 Apelbaum *et al*., 1; Kaur- Sawhney and Galston, [15]. Polyamines in holding solutions delayed the senescence in the petal tissue and extended the vase life of cut flowers of gladiolus Sivaprakasam *et al*., [27], carnation Bagni and Tassoni, [2] and rose Sumathi *et al*., [30]. Salicylic acid, phenolic compound Kazemi *et al*., [16] and α-lipoic acid, have been known to have antioxidative property which has contributed in extending vase life of cut flowers Danaee, *et al*., [7]. Hence, this experiment was intended to study the influence of polyamines (spermine, spermidine and putrescine), salicylic acid and α-lipoic acid on postharvest physiology of gerbera with the basic objective to extend its vase life.

Materials and Methods
Experiment was conducted in Floriculture laboratory, gerbera flowers were obtained from the green house complex of the department of Floriculture and Landscape Architecture at ACHF, NAU. The experiment was carried out in completely randomized design with three repetitions. Fully opened gerbera with ray florets perpendicular to stalk with two outermost whorls of the disc florets opened were selected and sorted for uniform fresh weight (30 ±5 g), diameter (10.00 ± 0.5 cm), diameter of disc (3.5 ± 0.5 cm), girth of flower stalk (6.7 ± 0.5 mm) and

girth of neck (4.15 ± 0.5 mm). Flower stalks were given angular cut at 45 cm and held in bottles containing 400 ml of vase solution. Vase solution consisted of 10 ppm spermine (T_1), 20 ppm spermine (T_2), 10 ppm spermidine (T_3), 20 ppm spermidine (T_4), 10 ppm putrescine (T_5), 20 ppm putrescine (T_6), 10 ppm salicylic acid (SA) (T_7), 20 ppm salicylic acid (SA) (T_8), 10 ppm α-lipoic acid (T_9), 20 ppm α-lipoic acid (T_{10}) and control (T_{11}). Thus, 200 mg/l 8-HQC as an antimicrobial agent and 2 % sucrose as carbohydrate source were commonly used in all treatments along with control. Total soluble sugars (mg/g), phenols (mg/g) and protein in the petal tissue (mg/g) were estimated by the methods given by Franscistt *et al*. [11], Malik and Singh [21] and Lowry *et al*. [20] respectively. Electrolytic leakage (%) in the petal tissue was estimated as per the method earlier used in gladiolus Singh *et al*., [26]. Anthocyanin content (mg/g) in the petal tissue was estimated as described by Swain and Hillis [31] and lignin (%) in the flower stalk was estimated by the method of Lopez *et al*. [19], on 8th day of vase life. Further, vase life of gerbera was evaluated by counting the number of days taken from the first day of vase life to till the day of the appearance of the first symptom of floret shrivelling and wilting. Statistical analysis was done by adopting the appropriate standard error (S.Em±) method as suggested by Panse and Sukhatme [23].

Results and Discussion

Gerbera cut flowers treated with spermine @ 10 ppm retained maximum fresh weight (38.01, 38.15, 24.27 and 21.88 g) and recorded maximum total soluble sugars (34.95, 38.78, 41.15 and 33.72 mg/g) and protein (23.09, 26.00, 27.26 and 17.29 mg/g) in the petal tissue which was at par or followed by salicylic acid @ 20 ppm as compared to control. Further, phenols in the petal tissue were also maximum in salicylic acid @ 20 ppm and spermine @ 10 ppm. Electrolytic leakage in the petal tissue was minimum in gerbera flowers held in spermine @ 10 ppm vase solution (19.49, 26.26, 33.21 and 43.07 %) which was at par with salicylic acid @ 20 ppm treatments. Fresh weight retention is dependent on maintenance of carbohydrate level and water uptake. Spermine is known for its anti-senescence effect during ageing sequence of plant tissue Kaur-sawhney and Galston, [15] that indirectly retains fresh weight as studied earlier in gerbera Bagni and Tassoni, [2], in heliconia Mangave *et al*., [22] and in rose Sumathi *et al*., [30]. Higher retained fresh weight in flower is known to restrict the degradation of macromolecules *viz.,* starch, proteins, nucleic acid, lipids and stimulate their synthesis Graham *et al*., [12] in the petal cells and thus contributed to maintained higher levels of TSS as studied earlier in gladiolus Singh *et al*., [26] and heliconia Mangave *et al*., [22]. Further, Salicylic acid plays vital role in conversion of complex sugars to simple forms Satraj *et al*., [24] and is also known to be assumed to inhibit polysaccharide-hydrolyzing enzyme system to influence TSS levels in plant cells. Maintained higher proteins and phenols in the petal tissue with spermine and salicylic acid treatments can be attributed to their anti oxidative property Kazemi *et al*., [16] or through inhibition of specific proteases as per earlier reports Courtney *et al*., [5]. The retained TSS, phenols, protein levels in the petal tissue further diminished electrolyte leakage. In addition to this, polyamines contribute to cell structure through phospholipid binding Slocum and Galston, [28] cell or through polygalacturonic acids with different degrees of methylation D'Orazi and Bagni, [6] or to diferulic acid, Bagni *et al*., [3], that contributes in stabilization of primary cell wall structure Bagni and Tassoni, [2]. Stabilizing of membranous proteins with spermin treatments have been elucidated in gladiolus Kusano *et al*., [18] and in Nicotiana Shaziya *et al*., [25]. SA has been reported to cause increment in protein by activation of nitrate reductase and nitrate contents and its role in decreasing electrolyte leakage Fariduddin *et al.,* [10] and thereby maintaining membrane stability.

Anthocyanin content in the petal tissue and lignin content in the flower stalk was higher in the vase solution treatment of spermine @ 10 ppm, which was at par with salicylic acid @ 20 ppm, spermine @ 20 ppm and salicylic acid @ 10 ppm. Anthocyanins are vacuolar flavonoid pigments. Hence, maintained membrane integrity with spermine and salicylic acid treatments owing to diminished electrolyte leakage, retained higher amounts of anthocyanin in petal tissue as well as lignin content in the flower stalk. Similar results of retained higher anthocyanin pigment in petal tissue with spermine in rose Katarzyna *et al*., [14] and with salicylic acid have been reported in rose Zohre *et al*., [33].

Maximum vase life of gerbera cut flowers was achieved by the vase solution treatment of spermine @ 10 ppm (16.92 days) which was at par with salicylic acid @ 20 ppm (16.50 days). Enhanced vase life in these treatments can be attributed to higher retention of flower fresh weight with higher retention of TSS, proteins and phenols in the petal tissue and lignin content in the stalk. Correlation of retained fresh weight and higher TSS with vase life was well established in cut flowers. Further, diminished electrolyte leakage in the petal tissue with the treatments stabilised the petal cell structure and retained petal anthocyanin content and lignin content in stalk and ultimately delayed petal senescence and extended vase life by 4-5 days. Enhanced vase life have been reported with spermine in heliconia Mangave *et al*., [22] and in rose Sumathi *et al*., [30] and with salicylic acid in gerbera (Jamshidi *et al*., [13] and in alstroemeria Elnaz *et al*., [8].

Table 1: Influence of postharvest application of chemicals on fresh weight (g), total soluble sugars (mg/g) and protein (mg/g) of gerbera var. Alcatraz

Treatments		Fresh Weight (g)				Total Soluble Sugars (mg/g)				Protein (mg/g)			
		Day-4	Day-8	Day-12	Day-14	Day-4	Day-8	Day-12	Day-14	Day-4	Day-8	Day-12	Day-14
T_1	Spermine-10ppm	38.01	38.15	24.27	21.88	34.95	38.78	41.15	33.72	23.09	26.00	27.26	17.29
T_2	Spermine-20ppm	35.44	32.32	20.29	16.49	32.05	35.50	38.87	30.88	21.79	24.04	25.45	16.21
T_3	Spermidine-10ppm	34.51	30.24	18.20	16.32	31.00	33.47	37.47	30.98	20.77	23.01	24.54	15.10
T_4	Spermidine-20ppm	34.99	32.14	19.42	15.86	32.04	34.93	38.18	29.29	20.60	23.94	25.69	14.85
T_5	Putrescine-10ppm	32.01	30.49	18.84	-	30.49	34.13	37.59	-	19.61	23.66	25.79	-
T_6	Putrescine-20ppm	34.95	31.55	18.35	-	29.90	32.95	36.73	-	19.30	22.16	24.85	-
T_7	Salicylic acid-10ppm	35.23	33.20	20.51	17.75	31.34	35.13	38.64	31.17	20.64	23.80	25.37	16.72
T_8	Salicylic acid-20ppm	37.20	35.97	22.66	20.11	32.30	36.56	39.85	32.88	21.89	24.28	26.47	17.00

T_9	α-Lipoicacid-10ppm	35.22	30.24	18.05	-	28.81	32.78	36.93	-	19.23	21.69	23.82	-
T_{10}	α-Lipoic acid-20ppm	34.28	29.54	18.87	-	29.26	33.40	37.51	-	19.81	23.16	23.75	-
T_{11}	Control	29.28	27.31	15.26	-	27.59	32.14	36.29	-	17.94	20.39	22.98	-
S.Em.±		0.91	0.55	0.50	0.31	0.96	1.05	1.13	0.65	0.67	0.67	0.46	0.38
C.D. at 5%		2.72	1.62	1.49	1.02	2.80	2.92	3.36	1.85	2.03	1.74	1.26	1.01

Table 2: Influence of postharvest application of chemicals on phenols (mg/g), electrolytic leakage (%), anthocyanin (mg/g), lignin (%) and vase life of gerbera var. Alcatraz

Treatments		Phenols (mg/g)				Electrolytic leakage (%)				Anthocyanin (mg/g)	Lignin (%)	Vase life (days)
		Day-4	Day-8	Day-12	Day-14	Day-4	Day-8	Day-12	Day-14			
T_1	Spermine-10ppm	2.83	2.57	2.30	1.96	19.19	26.26	33.21	43.07	17.38	6.55	16.92
T_2	Spermine-20ppm	2.68	2.47	2.19	1.85	21.12	28.21	35.24	45.60	16.23	6.36	15.08
T_3	Spermidine-10ppm	2.61	2.34	2.12	1.86	23.01	29.94	36.98	46.23	15.78	6.03	14.25
T_4	Spermidine-20ppm	2.62	2.31	2.13	1.71	22.48	28.50	36.32	47.08	15.70	5.95	14.29
T_5	Putrescine-10ppm	2.55	2.25	2.09	-	24.47	31.15	38.32	-	15.47	5.72	13.13
T_6	Putrescine-20ppm	2.54	2.19	2.08	-	24.25	30.91	38.10	-	15.39	5.64	13.00
T_7	Salicylic acid-10ppm	2.70	2.40	2.13	1.80	22.09	28.38	35.50	46.13	15.91	6.31	15.33
T_8	Salicylic acid-20ppm	3.00	2.62	2.42	2.08	21.08	27.10	34.97	44.02	16.80	6.52	16.50
T_9	α-Lipoic acid-10ppm	2.48	2.28	2.07	-	24.51	31.44	38.07	-	14.92	5.76	13.42
T_{10}	α-Lipoic acid-20ppm	2.50	2.23	2.06	-	24.57	31.46	38.66	-	14.85	5.52	12.92
T_{11}	Control	2.36	2.22	1.95	-	26.09	33.18	41.17	-	14.17	4.19	12.08
S.Em.±		0.09	0.08	0.08	0.04	1.07	0.53	1.01	0.83	0.49	0.16	0.42
C.D. at 5%		0.28	0.24	0.25	0.15	2.95	1.61	3.03	2.46	1.47	0.49	1.26

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