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Post harvest physiology and quality of heliconia inflorescence cv. Golden Torch as influenced by antioxidants

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ABSTRACT

Effects of vase solutions comprising of 8-HQC, sucrose, calcium chloride, α-lipoic acid, sodium benzoate, spermine, citric acid and commercially available surfactant on post harvest quality and life of heliconia inflorescence were investigated. Vase solution treatments, T_4 (α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3%) and T_6 (Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%) effectively increased water uptake and retained fresh weight of heliconia inflorescence and maintained pigment (carotene) in the bracts. The same treatments also reduced the levels of catalase (CAT) and peroxidase (POD) enzymatic activities, decreased the lipid peroxidation (measured as TBARS) and improved per cent absolute integrity (PAI) in the bract. Maximum vase-life was recorded in heliconia inflorescence held in vase solution comprising of α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3% followed by spermine 100 mg/l and $CaCl_2$ 250 mg/l along with 8-HQC 250 mg/l + sucrose 3%.

Key words: Heliconia**,** quality, catalase, peroxidase, lipid peroxidation, vase-life.

INTRODUCTION

The inflorescences of *Heliconia psittacorum spathocircinata* cv. Golden Torch are unique and beautiful, sturdy and highly priced in flower market. Heliconia is gaining popularity in the international flower trade. Hence, addressing its postharvest problems and prolonging its vase-life for a considerable period would suffice to be highly beneficial. Some post-harvest problems like low water absorption and uptake, rapid bract and florets darkening and abscission or senescence have been known in heliconia (Paulo, 8). Developmental and senescence process of cut flowers are under hormonal control. The petal senescence is delayed or inhibited by cytokinin and gibberellic acid in cut flowers (Paulo *et al.*, 8; Singh *et al.*, 10). There is important role of different chemicals like germicides and sugars in form of vase solution on post-harvest flower quality and life of different cut flowers. Recently, role of polyamines and antioxidants in improving postharvest quality and life of cut flowers has been reported in gladiolus and carnation (Bagni and Tassoni, 1). Studies on postharvest physiology and molecular biology have been concentrated mostly on climacteric, *i.e.* ethylene sensitive type flowers (rose, carnation etc.) as compared to non-climacteric, *i.e.* ethylene insensitive type flowers (heliconia, gladiolus, tulips etc.). Therefore, this experiment was planned to improve the quality and post-harvest life of this high value flower by using antioxidants and germicides along with sucrose in vase solution.

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MATERIALS AND METHODS

Fresh cut inflorescence of heliconia cv. Golden Torch were obtained from a Floriculture Research Farm and brought to the laboratory at an ambient temperature (18-21°C). The experiment was conducted at Laboratory of Floriculture, ASPEE College of Horticulture and Forestry, NAU, Navsari during 2009-10. The experiment was laid out in completely randomized block design having 9 treatments of vase solution, *viz.*, T_1 = 8-HQC 250 mg/l, T_2 = 8-HQC 250 mg/l + sucrose 3%, T_3 = Calcium chloride 250 mg/l + 8-HQC 250 mg/l + sucrose 3%, T_4 = α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3%, T_5 = Sodium benzoate 0.1 µM + 8-HQC 250 mg/l + sucrose 3%, T_6 = Spermine 100 mg/l + 8 HQC 250 mg/l + sucrose 3%, T_7 = Citric acid 300 mg/l + 8-HQC 250 mg/l + sucrose 3%, T_8 = Commercially available surfactant 0.5%, and T_9 = control. Each treatment was repeated three times. Two hundred seventy cut inflorescence at three bract open stage from basal end were selected and sorted for uniform size (80 ± 5 cm) and fresh weight (110 ± 5g). Thirty inflorescence (10 in each replicate) were held in different vase solutions with 23 ± 2°C temperature and 80% RH in laboratory. Eighteen inflorescences from each treatment (six of each replicate) were used for biochemical analysis

[carotene pigment, catalase (CAT) and peroxidase (POD) enzymatic activities, lipid peroxidation and per cent absolute integrity (PAI) of cell membrane]. Twelve inflorescences per treatment were thus left to determine vase-life. CAT and POD activities, lipid peroxidation, per cent absolute integrity (PAI) of cell membrane was estimated (in triplicate) 8, 10 and 12 DAT using 3rd bract from basal end of inflorescence. Inflorescences were weighed and the change in fresh weight was calculated on the basis of initial fresh weight. The solution uptake by the cut inflorescence was recorded at regular interval and total water uptake was determined by summation at the end of vase-life evaluation. The carotene pigment content in bract was estimated by Wellburn (13) method, enzyme activities were estimated as per the method of Mahatma *et al.* (6). Lipid peroxidation was measured in terms of thiobarbutaric acid reactive substances (TBARS) concentration as described by Heath and Packer (5). Absolute integrity of cell membrane was calculated on the basis of electrolyte leakage of bracts using conductivity meter as explained by Costa *et al.* (3).

RESULTS AND DISCUSSION

Improvement in post-harvest life of cut flowers through vase solution treatments comprising of antibiotics and sucrose is known and exploited. However, research on polyamines and antioxidants for postharvest study in flowers is limited. In the present experiment, all the treatments comprising of germicides, antioxidants, polyamines along with sucrose as vase solution improved water uptake, fresh weight retention and floret opening (%) in the heliconia inflorescence as compared to untreated control (Table 1). Treatment T_4 (α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3%) showed the maximum water uptake and fresh weight retention and change in stage through floret opening followed by T_6, (Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%). Fresh weight retention is dependent on maintenance of carbohydrate level and water uptake. Inclusion of 8-HQC that possess strong antimicrobial activity contributed to increase in water uptake by providing resistance free solution flow in cut inflorescence of heliconia as also observed in gladiolus (Singh *et al.,* 9). Sucrose contributes in maintaining water balance in flowers by influencing osmotic pressure of petal cells (Halevy and Mayak, 4). Inflorescence held in vase solution comprising of other chemicals like α-lipoic acid, spermine along with 8-HQC and sucrose further enhanced total water uptake and retained fresh weight. Further, delayed senescence in inflorescence treated with α-lipoic acid or spermine along with 8-HQC and sucrose contributed to increase in total water uptake and higher fresh weight retention. Flower opening in general is known to be influenced by water uptake (Halevy and Mayak, 4), fresh weight retention (Singh *et al.*, 9), petal turgidity and absolute integrity of cell membrane (Torre *et al.*, 11). Thus, retained fresh

Table 1. Effect of vase solution on total water uptake, change in fresh weight and flower opening in bract of heliconia.

Treatment	Total water uptake (ml)	Change in fresh weight (%)			Flower opening in bract (%)
		5th day	9th day	13th day	
T_1- 8-HQC 250 mg/l	146.36	2.41	3.94	-	-
T_2- 8-HQC 250 mg/l + sucrose 3%	182.68	1.94	3.51	6.19	19.35
T_3- Calcium chloride 250 mg/l + 8-HQC 250 mg/l + sucrose 3%	197.79	1.49	3.09	5.65	28.74
T_4- α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3%	223.68	0.63	2.53	3.22	37.56
T_5- Sodium benzoate 0.1 µM + 8-HQC 250 mg/l + sucrose 3%	193.49	1.67	3.3	7.67	24.63
T_6- Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%	211.36	0.96	3.05	3.28	32.48
T_7- Citric acid 300 mg/l + 8-HQC 250 mg/l + sucrose 3%	126.54	2.15	3.63	7.83	16.24
T_8- Commercially available surfactant 0.5%	101.19	2.59	9.74	-	-
T_9- Control	122.39	2.68	10.65	-	-
CD at 5%	6.92	0.09	0.18	0.14	0.78
CV %	2.41	2.88	2.17	2.12	2.59

weight and water uptake influenced floret opening within the bract in heliconia inflorescence.

The retention of pigment content carotene (Table 2) in the bract of heliconia inflorescence was maximum in treatment combination of α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3% (T_4) followed by T_6 (Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%). Sucrose have exhibited protective role for the ultrastructure of the chromoplast from damaging and thus ensured the pigment (carotene) retention, as also observed in gladiolus with 8-HQC and sucrose vase solution treatment (Singh *et al.,* 9). Protective role of α-lipoic acid and spermine being antioxidant on cellular structure further ensured the pigment (carotene) retention.

Inflorescence treated with α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3% (T_4), followed by T_6 (spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%), exhibited higher CAT and POD activities on 8th, 10th and 12th day. Further, lipid peroxidation was also minimum in vase solution treatments comprising of α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3% (T_4), followed by T_6 (Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%), recorded on 8th, 10th and 12th day. α-lipoic acid being antioxidant may have facilitated in scavenging of reactive oxygen species (ROS), that minimized lipid peroxidation and stabilized cell membrane system. Sugars are known to reduce reserve remobilization and stimulate the synthesis of lipids. Spermine has been earlier known to act as uncompetitive inhibitors of lipoxygenase and inhibits lipid peroxidation (Borrel *et al.*, 2).

The absolute integrity of cell membrane in the bract tissue continuously decreased in all the treatments with the advance of vase-life (Table 3). However, the decrease in absolute integrity of cell membrane was gradual in vase solution treatments, *viz*., calcium chloride 250 mg/l (T_3) followed by α-lipoic acid 100 mg/l (T_4) and spermine 100 mg/l (T_6) along with 8-HQC 250 mg/l + sucrose 3%. The inflorescence held in these solutions (T_3, T_4 and T_6) recorded significantly higher maintained absolute integrity of cell membrane in bract tissue as compared to control as recorded on 8th, 10th and 12th day. The leakage of ions is known to coincide with the decrease in water content of the petal cells as recorded in rose (Meeteren, 7). Sugars are known to stabilize selective permeability of cell membrane and contribute in reduction of electrolyte leakage in petal cells (Van Doorn, 12). $CaCl_2$ component of the cell wall plays an essential role in constituting cross-bridges within the cell wall of plants thereby strengthening and protecting them from cell wall degrading enzymes (White and Broadley, 14). α-lipoic

Table 2. Effect of vase solution on pigment carotene content, catalase and peroxidase activities in heliconia.

Treatment	Carotene (µg/ ml)			Catalase (mM/ min/ g FW)			Peroxidase (mM/ min/ g FW)		
	8th day	10th day	12th day	8th day	10th day	12th day	8th day	10th day	12th day
T_1- 8-HQC 250 mg/l	2.25	1.27	-	0.25	0.18	-	1.3	0.96	-
T_2- 8-HQC 250 mg/l + sucrose 3%	1.99	1.47	1.02	0.38	0.27	0.19	1.08	0.84	0.58
T_3- Calcium chloride 250 mg/l + 8-HQC 250 mg/l + sucrose 3%	2.43	2.06	1.63	0.63	0.46	0.34	1.84	1.65	1.42
T_4- α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3%	2.61	2.11	1.99	0.68	0.48	0.38	2.62	2.14	1.97
T_5- Sodium benzoate 0.1 µM + 8-HQC 250 mg/l + sucrose 3%	2.13	1.95	1.47	0.63	0.43	0.32	1.83	1.65	1.40
T_6- Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%	2.45	2.09	1.69	0.64	0.47	0.33	2.14	1.76	1.67
T_7- Citric acid 300 mg/l + 8-HQC 250 mg/l + sucrose 3%	2.31	1.62	1.08	0.30	0.26	0.18	0.72	0.34	0.15
T_8- Commercially available surfactant 0.5%	1.79	0.95	-	0.33	0.16	-	1.21	0.95	-
T_9- Control	1.9	0.95	-	0.27	0.1	-	0.64	0.39	-
CD at 5%	0.08	0.06	0.04	0.20	0.01	0.01	0.05	0.04	0.03
CV%	1.99	2.14	2.08	2.25	2.23	1.96	2.10	1.96	1.87

Table 3. Effect of vase solution on lipid peroxidation, absolute integrity of cell membrane and vase-life of heliconia.

Treatment	Lipid peroxidation (µmol/g)			Absolute integrity of cell membrane (%)			Vase-life (days)
	8th day	10th day	12th day	8th day	10th day	12th day	
T_1- 8-HQC 250 mg/l	55.29	68.9	-	55.48	30.17	-	11.24
T_2- 8-HQC 250 mg/l + sucrose 3%	48.77	59.55	72.45	71.54	48.25	28.75	13.77
T_3- Calcium chloride 250 mg/l + 8-HQC 250 mg/l + sucrose 3%	47.01	53.32	60.39	78.45	60.18	46.08	14.32
T_4- α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3%	35.41	40.65	44.13	77.86	62.82	44.96	16.23
T_5- Sodium benzoate 0.1 µM + 8-HQC 250 mg/l + sucrose 3%	42.52	50.67	56.51	74.94	53.73	38.79	14.64
T_6- Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%	38.81	43.31	49.77	75.75	58.34	41.41	15.70
T_7- Citric acid 300 mg/l + 8-HQC 250 mg/l + sucrose 3%	51.10	64.58	77.48	63.41	46.52	23.21	12.88
T_8- Commercially available surfactant 0.5%	54.97	60.39	-	50.92	23.21	-	10.66
T_9- Control	55.74	76.63	-	41.32	11.03	-	10.30
CD at 5%	2.11	2.36	1.63	1.32	2.09	1.90	0.56
CV%	2.58	2.39	2.37	1.18	2.79	4.48	2.45

acid, being antioxidant would decrease leakage of ions. Since, lipids are important constituent for maintaining cell membrane permeability, higher levels of lipid peroxidation may enhance electrolytic leakage by decreasing membrane stability which was also observed by Singh *et al.* (10). Thus, in untreated inflorescence higher electrolytic leakage from bract tissue was a result of higher lipid peroxidation.

Heliconia inflorescence treated with different vase solution combinations, recorded enhanced vase-life as compared to untreated (control) cut spikes (Table 3). The maximum longevity of cut spikes was observed in treatment α-lipoic acid 100 mg/l + 8-HQC 250 mg/l + sucrose 3% (T_4) followed by, T_6 (Spermine 100 mg/l + 8-HQC 250 mg/l + sucrose 3%). The enhanced vase-life of cut inflorescence has been correlated with higher water uptake and fresh weight retention (Halevy and Mayak, 4; Singh *et al*., 10). Further, higher activity of catalase and peroxidase enzymes with minimized lipid peroxidation, stabilized the petal cell membrane system (high PAI) and enhanced vase-life.

This present study thus conclude that α-lipoic acid or spermine along with 8-HQC and sucrose in vase solution influence the post-harvest physiology and enhance vase-life of heliconia inflorescence cv. Golden Torch.

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