Asian Journal of Biological and Life Sciences | Original Research

Post storage physiology and vase life of low temperature stored tuberose cut spikes as influenced by α-Lipoic acid and polyfilm packaging

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Submitted : 20.01.2015 Accepted : 28.03.2015 Published : 30.04.2015

Abstract

Effect of antioxidant, α-lipoic acid along with sugars as pre-storage pulsing treatment and seal packaging with polyfilms *viz.*, HDPE(40µ), LDPE (40µ) PP (40µ) and PP(30µ) at low temperature (2°C) storage for 15 days on post storage physiology and life of tuberose cut spikes were investigated. Pre-storage pulsing of tuberose cut spikes with solution containing 50mg l^{-1} α-lipoic acid + 15% sucrose for six hours and seal packaging with HDPE 40 µ poly film significantly influenced spike fresh weight, petal total soluble sugar level, PAI (%) in floret tissue in low temperature stored cut spikes. Untreated low temperature stored tuberose cut spikes displayed drastic chilling injury and reduced vase life to 0-3 days after low temperature storage. These results suggest that prestorage pulse treatment of tuberose cut spikes with α-lipoic acid and packaging with HDPE during low temperature storage at 2°C temperature retains higher spike fresh weight, petal sugar levels, and stabilizes cell membrane integrity in petal tissue leading to a delay in petal senescence with 7 days of vase life even after 15 days of cold storage.

Key words : Tuberose, α-lipoic acid, FW, TSS, PAI etc.

INTRODUCTION

Tuberose cut spikes are popular owing to their white fragrant florets serially arranged on the sturdy spike. Flower market often faces the problem of frequent market gluts and price crash. Long distance transportation of tuberose cut spikes is further restricted due its limited vase life and deterioration in flower quality and chilling injury due to cold storage[1]. Further, low temperature storage has also been known to promote ethylene production that further triggers floral abscission and early senescence in tuberose[2]. Storage temperature and duration influence physiological activities like respiration and enzymatic activities in cut flowers that ultimately influence quality and vase life. Seal Packaging of cut flowers with polyfilms during cold storage has been known to play an important role in retaining flower quality, improving opening ability, reducing water loss during post storage phase in stored flowers [1, 3, 4]. α-lipoic acid, an antioxidant has been known to protect membranous system in plant cells with its action on quenching free radicals, that has been reported to be applied for delaying of flower senescence in gladiolus spikes[5]. Further, role of α-Lipoic acid on post storage physiology and life of flowers has yet not been explored/studied. Research on storage aspects of tuberose spikes is also meagre. Hence, this experiment was planned to study the role of pre-storage pulsing with α-lipoic acid and seal packaging with poly films during 15 days of low temperature (2°C) storage of tuberose cut spikes on their post storage physiology and vase life.

MATERIALAND METHODS

Plant and Packaging material

Fresh cut spikes of tuberose, cv. 'Prajwal' were obtained from Floriculture farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) and brought to the floricultural laboratory at ambient temperature (20-25°C). The experiment was laid out in Completely Randomized Design with Factorial concept (FCRD). There were 18 treatment combinations and each treatment was replicated three times. One thousand six hundred twenty spikes at two basal florets opened stage were sorted and selected for uniform sizes (80± 5) cm and fresh weight (90± 5g).

Poly films used for seal packaging of tuberose were polypropylene (PP of 40 and 30 µ), High Density Polythene (HDPE of 40 µ), and Low Density Polythene (LDPE of 40 µ).

Pulsing, Packaging and storage

Eighteen treatment combinations of pre-storage pulsing (50 mg l^{-1} α-lipoic acid along with 15% sucrose) and packaging (HDPE, PP and LDPE poly films) were prepared. Spikes were divided into three groups*viz.*, A, B and C, each of 540 spikes and given pulse treatment of α-Lipoic acid, 15% sucrose and distilled water respectively. Pulse treatment was given at ambient temperature 20-25°C, 60±5 RH for a period of 6 h. Thereafter, spikes from each group were divided into bundles each having 10 spikes. From each group, equal number of bundles were packed with PP, HDPE and LDPE poly films and same number of bundles were held in water as well as in Corrugated fibber box (CFB box without any packing) and then immediately placed at 2°C cold storage for a period of 15 days. 15 days later cut spikes were removed from cold storage, unpacked and held in distilled water for recording observations in laboratory at ambient temperature (20-25°C), 60+-5 relative humidity and average radiation around 18 µmolm2 s−1 for a period of 8+2h day-1. Thirty spikes from each treatment (Twelve of each replicate) were used for physiological analysis [Total soluble petal sugars, and PAI in floret tissue]. Eighteen spikes per treatment were thus left to determine vase life. FW, total soluble petal sugars and PAI were estimated (in triplicate) from spikes held in vase water in vase after 15 days of storage upon unpackaging using third, fourth and fifth floret from the basal end.

RESULTS

Per cent change in fresh weight (FW %)

α lipoic acid along with 15 % sucrose treatment and HDPE 40 µ packaging significantly retained higher spike fresh weight of tuberose cut spikes as recorded on 3 and 5th days after low temperature storage (DAS) when held in vase water. α- Lipoic acid pre storage treated tuberose cut spikes that were sealed packaged with HDPE at low temperature storage retained maximum spike fresh weight (94.92 and 71.93%) when held in water in vase after storage. Untreated spikes held in water during storage retained low spike fresh weight after storage.

Total soluble sugars (TSSµg ml^{-1})

HDPE packaged tuberose cut spikes that were prestorage treated with α-Lipoic acid along with 15 % sucroseretained higher total soluble sugars in petal tissue as recorded on 3 and 5thDAS when held in vase water. Maximum total soluble sugar (12.44 and 9.34 µg ml^{-1}) was recorded in petal tissue of tuberose cut spikes treated with 50mg l^{-1}α- Lipoic acid as pre-storage pulse solution and packaged with HDPE 40 µ. Untreated spikes held in water during storage retained lowtotal soluble sugars in petal tissue as recorded after storage when held in water.

Percentage absolute integrity (%)

Prestorage treatments of α-Lipoic acid and HDPE packaging significantly influenced Percentage absolute integrityin petal tissue of tuberose cut spikes as recorded 3DAS when spikes were held in vase water after removing from packages. Significantly maximumPAI (67.82 %) was recorded in pre-storage50mg l^{-1} α-Lipoic acid pulse treated cut spikes that were packaged with HDPE 40 µ and (T2P2). Untreated spikes held in water during storage retained minimum electrolyte leakage in petal tissue as recorded after storage when held in water.

Vase life

Prestorage treatments of α-Lipoic acid along with 15 % sucrose and HDPE packaging significantly influenced vase life of tuberose cut spikes as recorded when spikes were held in vase water after removing from packages. Significantly maximum vase life (7days) was recorded in treatment comprising of pre-storage pulsing with 50mg l^{-1} α- Lipoic acidand packaged with HDPE 40 µ (T2P2). Untreated spikes either held in water during storage or in CFB retained minimum orzero respectively vase life as recorded after storage when held in water.

DISCUSSION

Per cent change in fresh weight (FW %)

Prestorage pulsing with 50mg l^{-1} α-Lipoic acid and packaging with HDPE or polypropylene polyfilm during cold storage were highly effective in improving post storage physiological factors influencing the vase life of tuberose cut spikes after 15 days of low temperature storage. α- Lipoic acid pre storage treated tuberose cut spikes that were sealed packaged with HDPE at low temperaturestorage retainedaveragely maximum spike fresh weight (93.17 and 70.54%) when held in water in vase after storage. Seal packaging of cut spikes resulted into modification of internal gaseous components (CO_2 and O_2), with highly modified atmosphere being created with HDPE and PP packaging (4.80 and 3.60 CO_2 respectively). Seal packaging of fresh produce in poly films is known to create modified internal gaseous components passively[6], that helps in minimizing metabolic activities during storage and retains fresh produce in normal condition[7,4]. Poly film types and their permeability properties have been known to influence gaseous composition within seal packages of fresh produce[8,9,10,11]. Permeability of HDPE and PP to CO2 and O2 being lower than LDPE [12], contributed to higher accumulation of CO2 and lower O2 as compare to LDPE packaging and in regulating respiration rate of the tuberose cut spikes.Per cent fresh weight retention is known to be dependent on maintenance of carbohydrate level and water uptake in cut flowers. Role of sucrose in influencing osmotic potential of petal cell and maintaining of better balance in flowers is well known [13,14,15]. Thus, sucrose being taken up through vascular tissueduring pre-storage pulse and upon accumulation in the petal cells as indicates TSS (Table 1)[13].

Total soluble sugars (TSSµg ml^{-1})

Maximum mean total soluble sugar (13.44 and 9.85 µg ml^{-1}) was recorded in petal tissue of tuberose cut spikes treated with 50mg l^{-1}α- Lipoic acid along with 15 % sucrose as pre-storage pulse solution and packaged with HDPE 40 µ.The exogenous continuous increased supply of sugar in the form of pulse treatments and retained fresh weight (Table 1) contributed to retain TSS levels in petal cells. In untreated cut flowers, the limited photosynthates may undergo depletion due to respiration during storage. This condition leads to sugar stress in the cells for the further continuation of metabolic activities and there may be accelerated hydrolysis of cellular components *viz.*, carbohydrates, lipids and proteins as also observed by Van der Meuler [16].Sugars in petal cells restrict the degradation of macro molecules *viz.*, starch, proteins, nucleic acid, lipids and stimulate their synthesis is early known [17]. Lipoic acid increases intracellular glutathione levels. Glutathione is an important water-soluble antioxidant that is synthesized from the sulphur-containing amino acid cysteine. The availability of cysteine inside a cell determines its rate of glutathione synthesis. Alpha-dihydrolipoic acid (DHLA) has been found to increase the uptake of cysteine by cells in culture, leading to increased synthesis [18] glutathione is an important antioxidant in plants, animals, fungi, and some bacteria and archaea, preventing damage to important cellular components and cell wall structure caused by reactive oxygen species such as free radicals and peroxidases.[19,20]. The higher content of sugar in petal of sealed packaged cold stored tuberose cut spike indicates its slow hydrolysis into soluble sugars, apparently facilitated by high CO_2 and low O_2 concentration inside these packages.

Percentage absolute integrity (%)

Significantly maximum mean PAI (64.65 %) was recorded in pre-storage 50mg l^{-1} α- Lipoic acid along with 15 % sucrose pulse treated cut spikes that were packaged with HDPE t40 µ and (T2P2).Imbalance of water in cut flowers has been known to lead early breakdown of plasma membrane which releasing the leaches into the interspaces of plant tissue[21]. Sucrose has known to stabilize selective permeability of cell membrane[22,23]. α- lipoic acid being antioxidant play vital role in scavenging of membrane-damaging reactive oxygen species (ROS) and thus, stabilized cell membrane system and decreased leakage of ions.

Vase life

The enhanced vase life of tuberose cut spikes in these treatments can be attributed to continued and increased water uptake (data not mention) in the cut spikes, higher retention of

Table 1: Effect of pre-storage treatments and packaging films on per cent change in fresh weight (%) and total soluble sugars (µg/ml) in petals of tuberose spikes when held in vase after 15 days of low temperature storage

Per cent fresh weight (%) of tuberose spikes on day 3 in vase					Per cent fresh weight (%) of tuberose spikes on day 5 in vase				Total soluble sugars (µg/ml) in petals of tuberose on day 3 in vase				Total soluble sugars (µg/ml) in petals of tuberose on day 5 in vase			
Treatments	(T_0) No pulsing	(T_1) Sucrose (15%)	(T_2) α-lipoic acid 50 mg l^{-1}+ Sucrose (15%)	(P) mean	(T_0) No pulsing	(T_1) Sucrose (15%)	(T_2) α-lipoic acid 50 mg l^{-1}+ Sucrose (15%)	(P) Mean	(T_0) No pulsing	(T_1) Sucrose (15%)	(T_2) α-lipoic acid 50 mg l^{-1}+ Sucrose (15%)	(P) mean	(T_0) No pulsing	(T_1) Sucrose (15%)	(T_2) α-lipoic acid 50 mg l^{-1}+ Sucrose (15%)	(P) Mean
P_1 LDPE-40 µ	81.60	87.233	91.19	86.68	58.57	61.75	61.75	60.69	9.36	9.80	10.76	9.98	7.28	7.59	8.39	7.76
P_2 HDPE-40 µ	91.99	92.590	94.92	93.17	69.34	70.33	71.93	70.54	12.73	13.45	14.12	13.44	9.35	9.603	10.60	9.85
P_3 PP-30-µ	77.97	79.817	79.81	79.20	61.46	61.77	61.77	61.67	8.76	9.71	10.91	9.80	6.46	6.863	8.36	7.23
P_4 PP-40-µ	80.42	82.807	82.80	82.01	61.64	62.24	63.53	62.47	10.02	11.44	12.44	11.30	8.32	8.640	9.34	8.77
P_5 without polyfilm package (control)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P_6 Wet storage	74.43	76.393	80.43	77.09	-	-	-	-	9.27	10.47	12.47	10.74	-	-	-	-
(T) Mean	67.74	69.81	71.53	CV	51.57	52.54	53.24	CV	8.36	9.15	10.12	CV	6.30	6.59	7.34	CV
	T	P	TXP	1.81	T	P	TXP	1.59	T	P	TXP	4.76	T	P	TXP	3.81
LSD	0.86	1.21	2.09		0.56	0.80	1.38		0.30	0.42	0.73		0.17	0.25	0.42	

- Control spikes failed to show PAI and Vase life due to chilling injury.

Percentage absolute integrity (PAI) (%) 3rd DAS					Vase life of tuberose cuts pikes after 15 days of cold storage			
Treatments	(T_0) No pulsing	Sucrose (15%)	(T2) α-lipoic acid 50 mg l^{-1}+ Sucrose (15%)	(P) Mean	(T_0) No pulsing	Sucrose (15%)	(T2) α-lipoic acid 50 mg l^{-1}+ Sucrose (15%)	(P) Mean
P_1 LDPE-40 µ	54.48	56.22	58.22	56.31	3.35	4.55	5.55	4.49
P_2 HDPE-40 µ	62.29	63.82	67.82	64.65	4.60	5.64	6.64	5.63
P_3 PP-30-µ	55.14	55.77	56.54	55.82	2.54	3.60	4.60	3.58
P_4 PP-40-µ	52.92	53.09	54.14	53.39	4.86	5.10	5.24	5.07
P_5 CFB (control)	-	-	-	-	-	-	-	-
P_6 Wet storage	24.78	25.86	26.86	25.83	2.16	2.78	3.03	2.66
(T) Mean	41.60	42.46	43.93	Cv	2.92	3.62	4.18	cv
	T	P	TXP	1.84	T	P	TXP	5.01
LSD	0.93	0.75	1.30		0.12	0.17	0.30	

Table 2: Effect of pre-storage treatment and different packaging films on Percentage absolute integrity (PAI) (%) and vase life in tuberose spikes when held in vase after 15 days of low temperature storage.

- Control spikes failed to show PAI and Vase life due to chilling injury.

fresh weight and high petal sugar status. These conditions contributed to optimum continuation of the cell metabolism that facilitated cell growth and development, formation of cellular constituents and the liberation of energy for other cellular functions. Further, well established and stabilized membrane integrity and cellular structure as indicated by maintained higherPAI (Table 2) ultimately delayed petal senescence and increase the longevity in pulse treated tuberose cut spikes α-lipoic acid along with sucrose. Use of antioxidants in retaining membrane integrity and for antisenescence effects during aging has been known [5]. α- lipoic prevail oxidative damage retain cell structure. Calcium is known to bind cell wall middle lamellae, constitutes cross bridge which strengthened cell wall and is considered as the last obstacle prior to separation of the cells[24]. Rate of senescence often depends upon calcium status of the tissue; its increased level alters various parameters of senescence such as respiration, protein, chlorophyll content [25]. It is also known to enhance texture and structure of polymers of cell wall, establish cross link between pectin chains and free carboxyl group[26].Dieuaide[27]correlated sugar starvation in the petal cells with petal senescence. Sucrose is known to suppress, both starvation induced genes and senescence induced genes [28].

CONCLUSION

To conclude, pre storage pulse treatments of α-Lipoic acid along with15 % sucrose for 6 hours and sealed packaging with HDPE poly film during the low temperature storage influenced the parameters affecting post storage life of tuberose cut spikes. These treatments improved the spike fresh weight retention, percentage absolute integrity and sugar content in petal tissue that ultimately delayed senescence and enhanced vase life of low temperature stored cut spikes.

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