Effect of Cold Storage and Preservative Solutions on Vase Life of Bird of Paradise (*Strelitzia reginae*) Cut Flowers

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ABSTRACT: This experiment was carried out during two successive seasons of (April and November, 2016) on bird of paradise (*Strelitzia reginae*) cut flowers at laboratory of the Plant Production Department, Faculty of Agriculture Saba Basha, and Refrigerator of Faculty of Agriculture, Alshatby, Alexandria University, to study the effect of cold storage and preservation solution on vase life of bird of paradise (*Strelitzia reginae*). A split plot designed experiment with three replicates treatments for each as follow: Silver thiosulphate (STS) (0.463mM), Silver thiosulphate (STS) (0.463mM) + *Matricoria Chamomilla* (ME) extract at 250mg/L, Silver thiosulphate (STS) (0.463mM) + *Ocimum basilicum* (OE) extract at 250 mg/L, Citric acid at 150 mg/L+8-hydroxy quinolene sulphate (8-HQS) at 250 mg/L as pulsing solutions and sucrose (S)20%+ Silver thiosulphate (STS) as holding solutions, and effect of storage at (10°C) for 0,1,2 and 3 weeks. Control characters were immersed in distilled water and kept at room temperature (18$\pm$2 °C) The obtained results showed that cold storage at (10°C) for one-week with silver thiosulphate (STS) (0.46mM) and *Ocimum basilicum* (OE) extract at (250 mg/L) pulsing treatments caused a significant increase of the physical characters as floret diameter, vase life, spike fresh and dry weights (g), opening %, chlorophyll a, b and total chlorophyll and gave the highest mean values of chemical compositions as total sugars (%); reducing sugars (%); non-reducing sugars (%), compared with control treatment which gave the lowest mean values of the all physical and chemical composition during both experiments.

Keywords: Bird of paradise (*Strelitzia reginae*), cold storage, preservative solution, vase life, physical character, chemical composition

INTRODUCTION

Bird of paradise (*Strelitzia reginae* Ait) plant belongs to Family Strelitziaceae and considers one of the most important cut flower crops in different countries. It occupies a high rank in the floral market and is also used in landscape design. This flowers exhibit irregular and incomplete floret opening as well as floret wilting within a few days after harvest. The challenges encountered by growers of tropical flowers like *Strelitzia reginae*, are mostly the flowering control and ensuring adequate vase life (Pizano, 2005).

The vase life of cut flowers and foliage is often shortened by vascular occlusions that constrict vase solution supply. Reduction in stem conductivity is typically caused by blockage of cut stem ends and xylem conduits by microbes, physiological plugging, and disruption of water columns in xylem vessels by cavitation and air emboli. Cut flower and foliage longevity can be greatly affected by the chemical composition of the vase solution. A broad range of biocides has been suggested to prevent the proliferation of microorganisms in vase solutions; however, their assumed antimicrobial action may be confounded by their other physicochemical effects (Edrisi *et al.,* 2012).

Longevity of vase life is an important factor in consumer preference. On the other hand, short postharvest vase life is one of the most limiting factors related to cut flowers (Kader, 2003 and Ahsan *et al.,* 2012).

The use of low temperature during storage is important for the conservation of the flowers, because in addition to inhibiting bacterial and fungal infections, it reduces degradation of certain enzymes and ethylene production; it reduces sweating, breathing and slows the various processes related to growth and senescence (Nowak *et al.,* 1990, Ashrae, 1994 and Sanino, 2004).

The use of chemical treatments and cold chamber storage in postharvest management improves the longevity of cut flowers, therefore lengthening their marketing period (Nowak *et al.,* 1990; Paiva *et al.,* 2004; Khan *et al.,* 2015).

Depending on the species, low temperatures during storage may induce changes in protein content (Thomashow, 2001) and peroxidase activity, as they are related to stress conditions (El Hilari *et al.,* 2003). Under cold storage, a decrease in enzyme activity was noted in bracts of *S. reginae* on the twelfth day, while in petals, an increase in enzyme activity was found on the fourth day, which remained almost constant with successive days in storage (Vieira *et al.,* 2015).

Sucrose acts as a source of food supply and respiratory substrate that enhances the quality of cut flowers and extends the vase life by extending the span of flowers showing color as it provides sufficient energy to ensure continuous development of flowers after harvest. The use of preservatives such as 8-HQS and sucrose increased the vase life of cut stock cultivars (Song *et al.,* 1996).

Silver nitrate ($AgNO_3$) and silver thiosulphate (STS), which interfere the binding sites of ethylene, are the common forms of silver salts used in commercial flower preservative solutions. Pulsing with $AgNO_3$ has reported to enhance the vase life of roses (Singh and Tewari, 2002; Darras *et al*., 2010; Elgimabi, 2011).

The extracts from Ocimum plant contains the following compounds 1,8 cineol, eugenol, methyl eugenol, thymol, p-cimene, cis-ocimene, and cis-caryophyllene, and, in different concentrations inhibited the growth of *Staphylococcus aureus, Shigella flexneri, Salmonella enteritidis, Escherichia coli*, *Klebsiella sp Proteus mirabilis, and Pseudomonas aeruginosa* (Ntezurubanza *et al.,* 1987).

The flower of German chamomile is strongly aromatic and has a bitter taste. The main constituents of chamomile include several phenolic compounds primarily flavonoids, including flavone glycosides (e.g., apigenin 7-glucoside) and flavonols (e.g., quercetin glycosides and luteolin glucosides), it also contains terpenoids, chamazulene and sequiterpenes Apigenin 7-glucoside is one of the main components of the flowers (Srivastava and Gupta, 2007).

The aims of the study:

- To determine the most suitable transactions to prolong the life of flowers for export.
- Conservation of the environment through the use of natural compounds to reduce pollution.
- Access to the best practical results the producer can use to improve and prolong flower life when exporting or local trading.

MATERIALS AND METHODS

This experiment was carried out at laboratory of the Plant Production Department, Faculty of Agriculture Saba Basha, and post-harvest processing unit at the Faculty of Agriculture, Alshatby, Alexandria University. During two successive seasons on (April and November, 2016).

Plant materials:

Bird of paradise (*Sterlitzia reginae*) cut flowers were obtained from a well-known commercial nursery in Cairo. The flowers were harvested early in the morning at the color bud stage (the first emerging orange flower), quickly transported to the laboratory under dry conditions uniform flower spikes of 90cm before postharvest treatments and placed in preservative solutions under laboratory condition temperature of (18 ± 1^{o} C) and (50-60%) relative humidity.

Flowers were divided to equal and similar four groups for storage:
Transported three groups quickly after the dried and packaged cellophane bags to refrigerator (Faculty of Agriculture, Al Shatby) for storage at (10^{o} C).

The treatments illustrated as follows:

A**) Storage Time (main plots**)

- Without storage.
- Stored one week,
- Stored two weeks,
- Stored three weeks.

B) **Pulsing solution (Sub-plots)**

- Control: distillated water (D.W)
- Silver thiosulphate (STS) (0.463mM)
- Silver thiosulphate (STS) (0.463mM) **+** *Matricoria Chamomilla* (ME) extract at 250 mg/L.
- Silver thiosulphate (STS) (0.463mM) **+** *Ocimum basilicum* (OE) extract at 250 mg/L.
- Citric acid at 150 mg/L**+**8-hydroxy quinolene sulphate (8-HQS) at 250 mg/L.

Holding solutions:

The flowers were moved to vases which contained 250 ml of:

- Control distilled water (D.W).
- Silver thiosulphate (STS) 200 mg/L **+** sucrose 20%.

Experimental layout

The treatments were arranged in split-plot design in two factors (cold storage and preservative solutions) with three replications for each treatment, each replicate consisted of one vase in which (4 cut flowers of bird of paradise) were placed.

Data recorded:

The collected data was:

A) Physical characters:

- Total fresh weight (g).
- Total dry weight (g).
- Vase Life (days).
- Flower diameter (cm)
- Number of florets blooming.

B) Chemical analysis

- Total sugars content in flowers (%):
  It was calculated in dry flowers at the beginning and every 4 days, sugars were extracted from five grams of flowers, the total sugars were determined colorimetrically using phenol and sulphuric acid according to (Malik and Singh, 1980).
- Reducing sugar (%) were determined by Nelson arsenate – molybdate colorimetric method (Dubois *et al*., 1956).
- Non-reducing sugar (%) were calculated by the difference between total sugars and reducing sugar.
- Chlorophyll (chlorophyll a, b and total) (mg/ g fresh weight) were determined in fresh stems of cut bird of paradise, chlorophyll was determined according (Dawood, 1993).

Statistical analysis

All the data collected were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). The treatment means were compared using L.S.D. test at 0.05 level of significant.

RESULTS AND DISCUSSION

A) Physical characters

Results recorded in Table (1) revealed that storage one week gave the highest mean values of physical characters as fresh weight (110.93 and 131.33g), dry weight (17.34 and 20.13g), and total chlorophyll (2.17 and 2.39mg/g Fw) respectively during both experiments compered to storage at three weeks which gave the lowest mean values of physical characters as fresh weight (58.70 and 85.29g), dry weight (9.85 and 16.07g), and total chlorophyll (1.15 and 1.36 mg/g Fw) respectively. On the other side, solution of STS+OE recorded the maximum mean values of physical characters as fresh weight (95.55 and 127.55g), dry weight (15.46 and 22.06g), and total chlorophyll (2.03 and 2.03mg/g Fw) during both experiments compered to control treatment which gave the minimum mean values of physical characters as fresh weight (68.12 and 90.93 g), dry weight (11.43 and 15.64 g), and total chlorophyll (1.72 and 1.77 mg/g Fw), respectively during both experiments.

The interaction between cold storage time and preservation solution on physical characters was significant during both experiments.

Table (1). Effect of cold storage time and some preservative solutions on mean Fresh weight, Dry weight and Total chlorophyll of bird of paradise (*Strelitzia reginae*) cut flowers.

Treatment	Fresh weight (g)		Dry weight (g)		Total chlorophyll (mg/gFw)	
	April	**Nov.**	**April**	**Nov.**	**April**	**Nov.**
A) Storage						
Without storage	88.74	119.38	13.91	22.31	1.75	2.15
One week storage	110.93	131.33	17.34	20.13	2.17	2.39
Two weeks storage	73.42	107.4	12.35	17.95	1.4	1.21
Three weeks storage	58.70	85.29	9.85	16.07	1.15	1.36
LSD (0.05)	** **0.37**	** **2.11**	** **0.06**	** **0.21**	** **0.021**	** **0.018**
B) Solutions						
D.W (control)	68.12	90.93	11.43	15.64	1.72	1.77
STS	94.21	125.75	15.17	21.78	1.74	1.98
STS+OE	95.55	127.55	15.46	22.06	2.03	2.03
STS+ME	81.62	107.63	12.66	18.72	1.88	1.91
8-HQS+Citric acide	75.27	102.65	12.12	17.41	1.81	1.83
LSD (0.05)	** **0.97**	** **3.52**	** **0.215**	** **0.28**	** **0.11**	** **0.027**
Interaction AXB	**	**	**	**	**	**

Data presented in Table (2) indicated that storage one week gave the highest mean values of physical characters as vase life (27.09 and 27.52 days), flower diameter (1.75and 2.02cm), and Number of florets blooming (2.15 and 2.04), respectively during both experiments compered to storage at three weeks which gave the lowest mean values of physical characters as vase life (13.67 and 11.53 days), flower diameter (1.01 and 1.02cm), and number of florets blooming (0.87 and 1.11), respectively. On the other side, solution of STS+OE recorded the maximum mean values of physical characters as vase life (22.25 and 21.55 days) flower diameter (1.48 and 1.65cm), and number of florets blooming (1.79 and 1.71), respectively during both experiments compered to control treatment which gave the minimum mean values of physical characters as vase life (19.50 and 18.65 days), flower diameter (1.30 and 1.39cm), and number of florets blooming (1.49 and 1.54), respectively during both experiments.

The interaction between cold storage and preservation solution on physical characters was highly significant during both experiments.

Table (2).Effect of cold storage Time and some preservative solutions on mean Vase Life, Flower diameter and Number of florets of bird of paradise (*Strelitzia reginae*) Cut Flowers

Treatment	Vase Life (days)		Flower diameter (cm)		Number of florets	
	April	**Nov.**	**April**	**Nov.**	**April**	**Nov.**
A) Storage						
Without storage	24.09	24.16	1.57	1.81	1.85	1.76
One week storage	27.85	27.52	1.75	2.02	2.15	2.04
Two weeks storage	17.64	16.45	1.26	1.27	1.08	1.39
Three weeks storage	13.67	11.53	1.01	1.02	0.87	1.11
LSD (0.05)	** **0.06**	** **0.03**	** **0.005**	** **0.006**	** **0.012**	** **0.004**
B) Solutions						
D.W (control)	19.5	18.65	1.3	1.39	1.49	1.54
STS	20.95	20.21	1.38	1.59	1.68	1.49
STS+OE	22.25	21.55	1.48	1.65	1.79	1.71
STS+ME	20.07	19.12	1.47	1.46	1.46	1.53
8-HQS+Citric	21.29	20.04	1.34	1.49	1.47	1.58
LSD (0.05)	** **0.05**	** **0.05**	** **0.015**	** **0.018**	** **0.019**	** **0.061**
Interaction AXB	**	**	**	**	**	**

B) Chemical characteristics

The results of the chemical composition of bird of paradise are shown in (Table 3) as affected by storage one week. Regarding the chemical composition, the cold storage for one week significantly increased the all chemical compositions studied i.e., total sugars (3.43 and 3.78%), reducing sugars (2.31 and 2.54 %) and non-reducing sugars (1.12 and 1.06%) respectively, While, three weeks cold storage treatment gave the lowest mean values of total sugars (1.53 and 2.12 %), reducing sugars (1.03 and 1.45 %) and non-reducing sugars (0.50 and 0.67%) respectively, On the other side, solution of STS+OE recorded the maximum mean values of chemical characters as total sugars (2.75 and 3.52%) reducing sugars (1.74 and 2.3 %) and non-reducing sugars (1.76 and 0.93%) respectively, while, control treatment gave the lowest mean values of total sugars (2.12 and 2.83 %), reducing sugars (1.46 and 1.9 %) and non-reducing sugars (0.66 and 0.93%) during both experiments.

The interaction between cold storage and preservation solutions on chemical characters were significant during both experiments.

These results are in agreement with those obtained by A pulsing treatment following storage for 7 and 14 days improved flower vase life by increasing the number of open florets. The best extension of post-storage longevity occurred after storing flowers up to 14 days at 10º C (Finger *et al.*, 2003).

on *Gloriosa* cut flowers cold storage at 4°C for 7 days has the potential to be used for delaying inflorescence senescence, prolonging vase life and postharvest quality (Hettiarachchi and Balas ,2005).

The pulsing treatment containing anti-ethylene improved the postharvest quality, and the cold-stored cut flowers showed more improvements in the postharvest quality than the cut flowers without cold storage (Geng *et al.*, 2009).

As the cold storage period was increased from zero-time to 21-days, on chrysanthemum cut flowers the above-mentioned characters of cut flower longevity and quality were decreased. When pulsing applications interacted with cold storage periods then subjected to holding solution treatments (Abou El-Ghait et al., 2012).

Table (3).Effect of cold storage time and some preservative solutions on mean Total sugars, Reducing sugar and Non-reducing sugar of bird of paradise (*Strelitzia reginae*) cut flowers

Treatment	Total sugars		Reducing sugar		Non-reducing sugar	
	April	Nov.	April	Nov.	April	Nov.
A) Storage						
Without storage	2.4	3.46	1.61	2.28	0.79	1.18
One week storage	3.43	3.78	2.31	2.54	1.12	1.24
Two weeks storage	1.92	2.77	1.29	1.82	0.63	0.95
Three weeks storage	1.53	2.12	1.03	1.45	0.50	0.67
LSD (0.05)	** **0.003**	** **0.025**	** **0.014**	** **0.01**	** **0.06**	** **0.012**
B) Solutions						
D.W (control)	2.12	2.83	1.46	1.9	0.66	0.93
STS	2.30	3.05	1.59	1.99	0.71	1.06
STS+OE	2.75	3.52	1.74	2.30	1.01	1.22
STS+ME	2.25	2.92	1.49	1.99	0.76	0.93
8-HQS+Citric	2.17	2.85	1.52	1.94	0.65	0.91
LSD (0.05)	** **0.06**	** **0.039**	** **0.023**	** **0.020**	** **0.065**	** **0.024**
Interaction AXB	**	**	**	**	**	**

CONCLUSION

in conclusion, the present study demonstrates that cold storage at 10℃ for one-week with silver thiosulphate (STS) (0.46mM) and Ocimum basilicum (OE) extract at (250 mg/L) pulsing treatments caused a significantly increase of the physical characters as floret diameter, vase life, spike fresh and dry weights (g), opening %, chlorophyll a, b and total chlorophyll and gave the highest mean values of chemical compositions as total sugars (%); reducing sugars (%); non-reducing sugars (%), compared with control treatment which gave the lowest mean values of the all physical and chemical composition during both experiments.

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الملخص العربي

تأثير التخزين البارد ومحاليل الحفظ على فترة حياة أزهار عصفور الجنة

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أجريت هذه التجربة خلال موسمين متتاليين (أبريل ونوفمبر ٢٠١٦) على أزهار نبات عصفور الجنة في معمل قسم الإنتاج النباتي بكلية الزراعة سابا باشا ، وثلاجه كلية الزراعة – الشاطبي ، جامعة الإسكندرية ، لدراسة تأثير التخزين المبرد ومحاليل الحفظ على فترة حياة ازهار عصفور الجنة وتم تصميم تجربة قطع منشقة مره واحدة بثلاثة مكررات وكانت المعاملات عبارة عن (ثيوسلفات الفضة)،(ثيوسلفات الفضه+زيت البابونج) (ثيوسلفات الفضه+زيت الريحان) ،(حمض الستريك +٨–هيدروكسي كينولين)، كمحاليل نابضة و(سكروز ٢٠٪ + ثيوسلفات الفضة) كمحلول حفظ ، وأثر تخزينها على درجة حرارة ١٠ درجات لمدة صفر،واحد ،اثنين،ثلاثة أسابيع وكان الكنترول هو الماء المقطر وأبقى في درجة حرارة الغرفة (١٨± ٢°) وقد أظهرت النتائج التي تم الحصول عليها أن التخزين البارد في ١٠ درجات لمدة أسبوع واحد مع استخدام ثيوسلفات الفضة(0.46mM) و زيت الريحان (٢٥٠ مجم/ لتر) ادت الى زيادة معنوية في الصفات الفيزيائية مثل قطر الزهرة ، فترة حياة الزهرة ، وارتفاع الأوزان الطازجه والجافة ، ومحتوى الكلوروفيل a، b والكلوروفيل الكلي وأعطت أعلى القيم للصفات الكيميائية مثل السكريات الكلية (٪) ؛ السكريات المختزلة (٪) ؛ السكريات غير المختزله (٪)، مقارنة بمعاملة الكنترول التي أعطت أدنى قيم لكلا من التركيب الفيزيائي والكيميائي خلال التجربتين.