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Effect of Some Preservative Solution Treatments on Characters of *Strelitzia reginae* Cut Flowers

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Abstract: The present work aimed to study the effects of some preservatives materials treatments{Silver thiosulphate (STS), 8-hydroxy quinolene sulphate (8-HQS), sucrose (S), ethanol extracts from sweet basil (*Ocimum basilicum* L., Labiatae) and German chamomile (*Matricaria chamomilla* L., Compositae)} as pulsing solutions and {sucrose (S), 8-hydroxy quinolene sulphate (8-HQS) and citric acid}as holding solutions as well as their combination ones on the postharvest characters, water relation characters, bacterial counts and some chemical constituents of *Strelitzia reginae* cut flower. In addition, the data recorded were postharvest characters (longevity and floret opening percentage), water relation characters (water balance), average of bacterial counts in vase solution and some chemical constituents (anthocyanin pigments and the percentages of total sugars). Generally, the higher quality and the longest vase life of *Strelitzia reginae* cut flower were obtained by using the interaction treatments between silver thiosulphate (STS) (0.463 mM) for 30 minutes then 10% sucrose (S) + 200 ppm 8-hydroxy quinolene sulphate (8-HQS) for 12 hours followed by silver thiosulphate (STS) (0.463 mM) for 30 minutes then 10% sucrose (S) + 200 ppm ethanol extracts from sweet basil as pulsing solutions and holding solution contained (sucrose at 5% + 8-hydroxy-quinolene sulfate at 200 ppm + citric acid at 150 ppm) compared to the other ones under study.

Key words: Preservatives materials, characters, strelitzia, cut flowers

INTRODUCTION

Nowadays, cut flowers are considered one of the most important products for export to foreign markets. Also, cut flowers occupy an important position in the local and foreign markets because of their importance as a source of national income. *Strelitzia reginae* (bird of paradise) is planted for their cut flowers. They are very important flower crops for local and foreign markets.

The preservatives materials used as pulsing or holding solutions seemed to prolong flower longevity. In this respect, some preservatives materials, i.e. sucrose , 8-hydroxy quinolene sulphate (8-HQS), ethanol extracts from sweet basil (*Ocimum basilicum*) and German chamomile (*Matricaria chamomilla*) or silver thiosulphate (STS) as pulsing solutions and sucrose, 8-hydroxy quinoline sulphate (8-HQS) or citric acid (CA) as holding solutions were used in prolonging vase life. Also, Sucrose inhibited ethylene synthesis as well as promoting bud opening and inhibiting flower senescence of cut snapdragon flowers (Ichimura and Hisamatsu, 1999). Furthermore, 8-hydroxy quinoline salts (8-HQ) delayed senescence and eliminated bacterial growth which was the principal reason for reduced water uptake and transport of gerbera flower (Abdel Kader, 1987). With the presence of sucrose, addition of a germicide such as 8-HQS is a necessary to inhibit microbial growth (Sacalis 1993). Reid et al. (2001) reported that pulsing solution treatment (20% sucrose + 250 ppm 8 HQC) significantly improved the vase life and opening of cut tuberose flower spikes. However, silver thiosulphate (STS) was the most effective as a bactericide and an inhibitor to ethylene production and action (Nowak and Rudnick, 1990). Sashikala et al. (2001) on gladiolus cv. Her Majesty reported that pulsing of spikes with 20% sucrose in combination with 4 mM silver thiosulphate resulted in maximum floret longevity and vase life. Sucrose reduced the initial water uptake due to the decrease in osmotic potential of sucrose solution. 8 HQS prevented the growth of microorganism in the xylem and thus maintained water uptake by flower stems. STS inhibited the action of ethylene and leading to a decrease in lipoxygenase (Lox) activity as well as served as an antibacterial component. Moreover, citric acid (CA) improved water balance and reduced stem plugging (Halevy et al., 1978) . 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.,

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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 & Gupta, 2007). The pharmacological effect of chamomile is mainly connected with its essential oils which explain its anti-inflammatory, antiseptic, healing, stimulative, carminative, spasmolytic, sedative activities and bacterial skin diseases. Essential oil content and its qualitative profile as well as the amount of chamazulene seem to be more genetically determined, while the reaction of the bisaboloids to these parameters could be more affected by growing conditions (Salamon, 2007).

Therefore, the present work aimed to study the effects of pulsing and holding solutions as well as their interaction treatments on post harvest characters, water relations, averages of bacterial counts and some chemical constituents of *Strelitzia reginae* cut flower. And study the possibility of using some of medicinal plants extracts compared with some chemical preservatives materials to improve flower quality during cold storage and shelf life.

MATERIALS AND METHODS

The present work was conducted at the laboratory of Horticulture Department, Faculty of Agriculture, Zagazig University during the two successive seasons of 2007and 2008. The bird of paradise (*Strelitzia reginae* L.) inflorescence consists of a boat-shaped bract containing a series of 5 or 6 flowers used in this study . The birds of paradise are members of the family Sterlitezaceae of the order Passeriformes. Brid of paradise cut flowers were used in the present work. The flowers were harvested in the morning, at the colored bud stage (The first emerging orange flower), from Agriculture Faculty Farm of Zagazig University. The flower spikes were warped in tissue paper, transported to the laboratory quickly, under dry condition. Uniform flower spikes of 90 cm. long and about 1 cm. diameter flower stalk were used. Brid of paradise cut flowers bases were recut to be (10 cm.) before treatments and placed in preservative solutions in glass containers ,under laboratory conditions i. e. 24 hours fluorescent light(about 500 lux),temperature of 25±2 °C and relative humidity between 60–70%. The experiment was started on the 1st November at both seasons.

The present work treatments could be under the following topics:

1. Pulsing solutions: Similar flowers were divided to equal and similar five groups for applying pulsing treatments in various chemical solutions.

1. First group was pulsed in distilled water (D.W) for overnight (12 h) (control treatment).
2. Second group was pulsed in silver thiosulphate (STS) (0.463 mM) for 30 minutes.
3. Third group was pulsed in silver thiosulphate (STS) (0.463 mM) for 30 minutes then sucrose (S) at 20% + *Ocimum basilicum* extracts (OE) at 200 ppm for 12 hours.
4. Fourth group was pulsed in silver thiosulphate (STS) (0.463 mM) for 30 minutes then sucrose (S) at 20% + *Matricaria chamomilla* extracts (ME) at 200 ppm for 12 hours.
5. Fifth group was pulsed in silver thiosulphate (STS) (0.463 mM) for 30 minutes then sucrose (S) at 20% + 8-hydroxy quinolene sulphate (8-HQS) at 200 ppm for 12 hours.

The pH of pulsing solutions was determined as shown in Table (A).The pH of pulsing solutions were measured with a Corning 125 pH meter at the initial treatments of *Strelitzia reginae* cut flower spike.

Table (A):. The pH of pulsing solution treatments at initial treatments.

Composition of the solution	pH
1- Distilled water (D. W.)	6.60
2- STS	4.60
3- STS then 20% S + 200 ppm OE	4.70 then 5.40
4- STS then 20% S + 200 ppm ME	4.70 then 5.70
5- STS then 20% S + 200 ppm 8-HQS	4.70 then 4.10

Preparation of Silver Thiosulphate Solution (STS):

Stock solutions of silver nitrate ($AgNO_3$) (0.1 M) and sodium thio-sulphate ($Na_2S_2O_3$, $5H_2O$) (0.1M) were stored in the dark as described by Reid *et al.* (1980). Silver thiosulphate (STS) was prepared as needed on the day of the experiment by combining calculated volumes of those solutions and distilled water (STS) was prepared according to Gorin *et al*., (1985) as follows:

1. Dissolving 0.079 g. ($AgNO_3$) in 500 ml distilled water [solution 1].
2. Dissolving 0.462 g. ($Na_2S_2O_3$, $5H_2O$) in 500 ml distilled water [solution 2].
3. Solution 1 was poured into solution 2 with stirring. The final concentration of silver was 0.463 mM.

Plant Materials And Extraction Procedure:

To prepare the tested plant material extracts, leaves of sweet basil (*Ocimum basilicum* L., Labiatae) and flowers of German chamomile (*Matricaria chamomilla* L., Compositae) plants were collected from the Agriculture Faculty Farm of Zagazig University. Fresh leaves of sweet basil were thoroughly washed using tap water and rinsed with distilled water. The leaves of sweet basil were dried for 30 min in an oven at 60°C to stop enzyme activity (Effraim *et al*., 2000), and flowers of German chamomile plants were dried . collected

plant material were dried at airy and shady place till a constant weight. The dried and powdered plant materials (500 g) were extracted successively with 1 L of ethanol by using Soxhlet extractor for 72 h. The extracts were filtered using Whatman filter paper (No. 1) and then concentrated in vacuo at 40 °C using a rotary evaporator. The residues obtained were stored in a freezer until further tests.

2. Holding solutions treatments: After pulsing solution treatments, *Strelitzia reginae* cut flower spikes of each group were separated into two parts. Each part was hold till the end of the experiment in holding solutions under lab condition as follows:

1. Control: placing *Strelitzia reginae* cut flower spike bases (12 cm) in distilled water (D.W.).
2. Holding solution (H.S.): placing *Strelitzia reginae* cut flower spike bases (12 cm) in sucrose (S) at 5% + 8 - hydroxyquinoline sulphate (8-HQS) at 200 ppm + Citric acid (CA) at 200 ppm .

The pH of holding solutions was determined as shown in Table (B). The pH of the vase solutions were measured with a Corning 125 pH meter at the initial treatments of *Strelitzia reginae* cut flowers.

Table (B): The pH of holding solution treatments at initial treatments.

Composition of the solution	pH
1- Distilled water (D. W.)	6.60
2- 5% (S) + 200 ppm (8-HQS) + 200 ppm (CA)	3.40

3. Interaction treatments between pulsing and holding solution treatments: Each treatment of pulsing solutions was combined with one of holding treatment solutions to consist 10 interaction treatments.

The treatments of the present work were arranged in a factorial experiment in complete randomized block design with three replicates. Each replicate consisted of one Jar. Three brid of paradise cut flower were held in the Jar (1000 ml size) containing 500 ml solution.

The Following Data Were Recorded:

1. Post Harvest Characters:

The longevity of *Strelitzia reginae* cut flower spikes (days) was determined when the wilted florets reach 75% from total the number of the florets on the spikes.

1.2- Floret opening percentage was calculated as a percentage of opened florets from all the florets on the cut spike at the end of longevity.

2. Water Relations:

The rate of water uptake and water loss per *Strelitzia reginae* cut flower spike was determined by weighting the jars with and without the flowers and correcting for the evaporation. Water balance per *Strelitzia reginae* cut flowers were measured and calculated as follows:

Water balance (g /spike) was calculated as the difference between water uptake and water loss after 15 days from the treatment.

***3.* Averages of Bacterial Counts (colonies / ml):**

Bacterial contamination was determined in the keeping solution after 15 days from the treatment. The samples of the preservative solutions were taken (1 ml of each) and diluted using sterilized distilled water. One ml of each diluted solution was streaked on nutrient agar into Petri dishes. Cultures were incubated 2 days at 28°C and the colonies appearing on the plates were counted as described by Marousky (1968). This experiment was repeated two times with 3 replicates in each treatment at the laboratory of Microbiology Department, Faculty of Agriculture, Zagazig University.

4. Chemical Constituent's Determinations:

Chemical constituents were determined after 15 days from the treatment (when control spikes were started to show wilting symptoms). They were implicated the flowing determinations:

Chemical Determinations:

Chemical determinations were done in flower petals at 15 days vase life. They were implicated the flowing determinations:

1. Anthocyanin Content (mg/100 g petals):

Anthocyanin pigment was extracted from flower petals using ethanolic / HCL solvent (95% ethanol: 1.5N HCL, 85:15) according to procedures of Fuleki and Francis (1968). Then, the pigment content was expressed as mg/ 100 g according to Luque-Rodríguez *et al.*, (2007).

2. Total Sugars Percentage:

Total sugars percentage was determined colorimetrically in the dried floret samples according to the method described by Smith et al., (1956).

Statistical Analysis:

The data of the present work were statistically analyzed according to Thomas and Hill (1978) and the differences between the means of the treatments were considered significant when it was more than least significant difference (L S D) at 5% and 1% levels.

RESULTS AND DISCUSSION

1. Effect of Pulsing Solution Treatments:

1-1. Post Harvest and Water Relations Characters:

Data presented in Table (1) indicate that, all pulsing solution treatments recorded highly significant increase in post harvest characters (longevity and floret opening percentage) and water relation characters (water balance)of *Strelitzia reginae* cut flower spikes when compared to control in the two seasons. The treatment of STS + S + 8-HQS showed highly significant increase longevity; floret opening percentage and water balance of bird of paradise cut flower spikes when compared to control and the other ones under study in the two seasons. Furthermore, the treatments could be arranged descendingly as follows: STS + S + 8-HQS > STS + S + OE > STS > S + ME > control. These results were recorded in the two seasons, as shown in Table (1). However, the increase in vase life due to (STS + S + 8-HQS) treatment was also found by Anju et al., (1999) on chrysanthemum and Kwon et al. (2000) on freesia. Furthermore, the increase in floret diameter, floret opening percentage, water uptake and water balance due to STS treatment was also found by Gendy (2000) on gladiolus cut flower spikes, El- Saka (1992) on bird of paradise, El-Bouhy (2002) on tuberose cut flower spikes.

Such increase in bird of paradise cut flower spikes longevity caused by (STS + S + 8-HQS) or (STS + S + OE) treatment might be attributed to that STS inhibited the action of ethylene and leading to a decrease in lip oxygenase (Lox) activity as well as served as an antibacterial component, sucrose reduced the initial water uptake due to the decrease in osmotic potential of sucrose solution, and 8-HQS prevented the growth of microorganism in the xylem and thus maintained water uptake by flower stems. (Kwon et al., 2000) on fressia and (Nowak and Rudnicki, 1990) on many cut flowers. In addition, sucrose inhibited ethylene synthesis as well as promoting bud opening and inhibiting flower senescence (Ichimura and Hisamatsu, 1999). Furthermore, 8-hydroxy quinoline salts (8-HQ) delayed senescence and eliminated bacterial growth which was the principal reason for reduced water uptake and transport of gerbera flower (Abdel Kader, 1987). 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).

1-2. Bacterial Counts (colonies/ ml):

The results tabulated in Table (1) reveal that all pulsing solution treatments highly significantly decreased the bacteria counts of *Strelitzia reginae* cut flower spikes when compared to the untreated spikes (control). Generally, pulsing bird of paradise cut flower spikes bases in 1 : 4 mM silver thiosulphate (STS) for 30 minutes then 20% S + 200 ppm 8-HQS or 20% S + 200 ppm OE for 12 hours recorded a decrease in number of bacteria in vase solution as compared to other treatments under study and control in the two seasons. Such increase was highly significant with the two seasons. Similar results were stated by Zagory and Reid (1986) on many cut flowers, Van Doorn (1997) on narcissus cut flowers, regarding (STS or 8-HQS).

Such effect could be attributed to that sugars in the solution were often reported to decrease transpiration. Sugars usually resulted in an increase in bacterial growth, which might lead to stomatal closure as a result of a water deficit, an effect not fully realized in most reports. Even when an antimicrobial compound was included, its effect was usually not fully checked Van Doorn (1997) on narcissus cut flowers. Also found that hydroxyl quinoline compounds, often used as antimicrobial agents, are also reported to result in stomatal closure. Inclusion of 300 mg/l of 8 HQC in the vase water at the onset of the experiment completely prevented the water stress symptoms in the rose flowers and prevented the increase in bacterial numbers in the basal end of the stems. 8HQC is an antibacterial compared, but also inhibits ethylene production compound. Also, he stated that treatment with the anti-ethylene compound sliver thiosulphate (STS) at the onset of the experiments had no effect on the occlusion in the rose stems induced by the presence of narcissi, and did not affect the number of bacteria in the stems. Also, Nell and Reid (2000) reported that the best way to overcome the microbe problem in the life of cut flowers is to ensure that flowers are placed in water containing chemicals that will prevent microbial growth. This is the reason that all effective commercial fresh flower foods contain anti-microbial compounds, or "biocides" that are intended to prevent growth of bacteria in flower vases and buckets. Unfortunately, if improperly used, preservatives may not control the growth of bacteria. However,

Ntezurubanza et al,1987 found that 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* .

1-3. Chemical Constituents:

Data shown in Table (1) reveal that all pulsing solution treatments highly significantly increased anthocyanin content in the petals and total sugars percentage in the florets of *Strelitzia reginae* cut flower spikes when compared to the untreated spikes (control). Pulsing *Strelitzia reginae* cut flower spikes bases in (STS + S + 8-HQS) or (STS + S + OE) for 12 hours recorded highly significant increase in anthocyanin content in the petals of bird of paradise cut flower spikes as compared to other treatments under study and control. These results are in similar to those reported by Gendy (2000) on gladiolus cut flowers, regarding (STS).

Table 1: Effect of pulsing solution treatments on longevity, floret opening percentage, water balance, bacterial counts, anthocyanin content and total sugars percentage of *Strelitzia reginae* cut flowers during two seasons.

Pulsing solutions	Vase life (days)	Floret opening Percentage	Water balance (g/spike)	Bacterial counts (colonies/ ml)	Anthocyanin (mg/100g)	Total Sugars%
First season						
D.W.	17.83	62.06	-4.51	416.19	6.91	2.95
STS	21.52	72.22	-0.48	260.41	7.46	3.17
STS+S+OE	24.57	79.87	1.24	256.42	7.79	3.21
STS+S+CE	19.76	76.96	-1.77	293.80	7.72	3.29
STS+S+8HQS	27.57	85.42	2.87	202.11	8.28	3.52
L.S.D. at 5%	0.27	0.21	0.15	1.94	0.10	0.03
L.S.D. at 1%	0.36	0.28	0.20	2.58	0.13	0.05
Second season						
D.W.	19.17	63.79	-5.07	452.81	7.18	3.02
STS	23.68	73.51	-0.55	268.63	7.56	3.20
STS+S+OE	25.73	79.88	1.94	272.20	7.86	3.25
STS+S+CE	20.99	78.49	-1.61	304.73	7.79	3.29
STS+S+8HQS	28.76	87.26	3.07	219.38	8.42	3.51
L.S.D. at 5%	0.22	0.18	0.48	1.40	0.06	0.04
L.S.D. at 1%	0.29	0.24	0.64	1.87	0.08	0.06

Distilled water (DW)-Silver thiosalphate (STS) - Ocimum Extracts(OE)- Chamomile Extracts(CE) - 8-hydroxy quinolene sulphate (8-HQS)- Sucrose (S)

2. Effect of Holding Solution Treatments:

2-1. Post Harvest and Water Relations Characters:

Results presented in Table (2) show that holding solution contained (50 g/l sucrose + 200 mg / l 8-HQS + 150 mg / l citric acid) highly significantly increased post harvest characters (longevity and floret opening percentage) and water relation characters (water balance) of bird of paradise cut flowers in comparison with control(D.W treatment) in the two seasons. Similar results were reported by Gendy (2000) on gladiolus, El-Saka (1992) on tuberose and bird-of-paradise and Reddy et al., (1995) on tuberose.

Table 2: Effect of holding solution treatments on longevity, floret opening percentage, water balance, bacterial counts, anthocyani content and total sugars percentage of *Strelitzia reginae* cut flowers during two seasons.

Holding solutions	Vase life (days)	Floret opening Percentage	Water balance (g/spike)	Bacterial counts (colonies/ ml)	Anthocyanin (mg/100g)	Total Sugars%
First season						
D.W.	20.12	71.26	-1.28	328.45	7.22	2.94
S+8HQS+CA	24.38	79.35	0.22	243.12	8.05	3.52
L.S.D. at 5%	0.17	0.13	0.10	1.23	0.06	0.02
L.S.D. at 1%	0.22	0.18	0.13	1.63	0.08	0.03
Second season						
D.W.	21.87	72.60	-1.54	344.82	7.30	2.99
S+8HQS+CA	25.46	80.57	0.47	262.28	8.22	3.52
L.S.D. at 5%	0.14	0.11	0.30	0.88	0.03	0.02
L.S.D. at 1%	0.18	0.15	0.40	1.17	0.05	0.03

Sucrose (S) - 8-hydroxy quinolene sulphate (8-HQS)- Citric acid (CA)

However, sucrose treatment might be increased longevity; floret opening percentage and water balance of bird of paradise cut flowers by delaying senescence throughout one or more of the following factors: promoting bud opening and inhibiting flower senescence might be attributed to an increasing sugar concentration and inhibition of ethylene synthesis, [Ichimura and Hisamatsu (1999)]. In this respect, Paulin (1986) summarized that effect of sucrose on cut flowers to be: 1) Morphological evaluation of the flower by

increasing the vase life, maintaining constant fresh weight, and regulate increase in the dry matter. 2) When cut flowers were supplied with sugar solution the soluble protein content increased in the petals. Glucose also favored the synthesis of amides. To prevent accumulation of ammonia, the flower developed a process of detoxication by producing amides, and also preserved various enzymatic activities. 3) The mobile form of carbohydrates by which energy sources were moved from the point of synthesis to the point of utilization. 4) Maintenance of osmotic pressure. 5) The delay of ethylene outburst. 6) The inhibition of phospholipids breakdown, thus maintaining membranous integrity and 7) protected the structure of mitochondria. However, the present results revealed that 8hydroxy quinolene salts (8-HQS) treatment delayed senescence and increased vase life of *Strelitzia* cut flower spikes. Such effect could be attributed to one or more of the following: 8HQ salts treatment prevented vascular blockage by reducing the number of bacteria in the stem, [Halevy and Mayak (1981) .The presented results showed that citric acid treatment prolonged the vase span of bird of paradise cut flower spikes. Such increase might be due to the following: citric acid was most widely used to decrease the pH of water, improve water balance and reduce stem plugging, [Halevy et al., (1978) on cut flowers]. Also, Phavaphutanon and ketsa (1989) on cut rose's cv. Christian Dior suggested that the vase life tended to increase by lowering the pH using citric acid.

2-2. Bacteria Counts (colonies/ml):

As shown in Table (2), the results indicate that holding bird of paradise cut flower spikes bases in holding solution contained (sucrose + 8-HQS + citric acid) recorded highly significant decrease in number of bacteria in vase solution as compared to control (D.W treatment). Similar results were stated by Zagory and Reid (1986) on many cut flowers, Van Doorn (1997) on narcissus cut flowers, regarding (8-HQS).

In this respect, Van Doorn (1997) found that sugars in the solution are often reported to decrease transpiration. Sugars usually result in increased bacterial growth, which may lead to stomatal closure as a result of a water deficit, an effect not fully realized in most reports. Even when an antimicrobial compound was included, its effect was usually not fully checked. Also he found that hydroxyl quinoline compounds, often used as antimicrobial agents, are also reported to result in stomatal closure. Inclusion of 300 mg/l of 8 HQC in the vase water at the onset of the experiment completely prevented the water stress symptoms in the rose flowers and prevented the increase in bacterial numbers in the basal end of the stems. 8HQC is an antibacterial compound, but also inhibits ethylene production compound, Van Doorn (1997) on narcissus cut flowers. Also, Nell and Reid (2000) reported that the best way to overcome the microbe problem in the life of cut flowers is to ensure that flowers are placed in water containing chemicals that will prevent microbial growth. This is the reason that all effective commercial fresh flower and foods contain anti-microbial compounds, or "biocides" that are intended to prevent growth of bacteria in flower vases and buckets. Unfortunately, if improperly used, preservatives may not control the growth of bacteria.

2-3. Chemical Constituents:

Data shown in Table (2) reveal that holding bird of paradise cut flower spikes bases in holding solution contained (sucrose + 8-HQS + citric acid) recorded highly significant increase in anthocyanin content in the petals and total sugars percentage in the florets of bird of paradise cut flower spikes compared to control (D.W treatment). Similar results were stated by Gendy (2000) on gladiolus cut flower spikes.

3. Interaction Treatments Between Pulsing and Holding Solutions:

3-1. Post Harvest and Water Relations Characters:

Data presented in Table (3) show that the treatments of interaction between pulsing and holding solutions under study highly significantly increased post harvest characters (longevity and floret opening percentage) and water relation characters (water balance) of *Strelitzia reginae* cut flower spikes compared to control in the two seasons. However, The interaction treatment between pulsing solution of (STS + S + 8-HQS) for 12 hours and holding solution contained (sucrose + 8-HQS + citric acid) recorded highly significant increase in longevity; floret opening percentage and water balance of *Strelitzia reginae* cut flower spikes . However , similar results were reported by Gendy (2000) on gladiolus respecting to the interaction treatments between pulsing solution of (STS) or (Ki) and holding solution contained (S + 8HQS+ CA), Reddy et al. (1995) , on gladiolus and El-Saka (1992) on tuberose regarding (S + 8HQS+ CA). Such increase in gladiolus cut flowers longevity due to the interaction treatments between pulsing solutions and holding solution of (S + 8-HQS + CA) might be attributed to that, each solution used alone of pulsing or holding treatments recorded a promotive effect in this connection as mentioned and attributed just before. Consequently, their combinations together might maximize their effects in this regard.

Table 3: Effect of the interaction between pulsing solutions and holding solutions on longevity, floret opening percentage, water balance, bacterial counts, anthocyanin content and total sugars percentage of *Strelitzia reginae* cut flowers during two seasons.

Pulsing solutions	Vase life (days)		Floret opening percentage		Water balance (g/spike)		Bacterial counts (colonies/ ml)		Anthocyanin (mg/100g)		Total sugars%	
	Holding solutions											
	D.W.	H.S.	D.W.	H.S.	D.W.	H.S.	D.W.	H.S.	D.W.	H.S.	D.W.	H.S.
First season												
D.W.	15.71	19.95	59.21	64.92	-5.51	-3.52	457.51	375.23	6.70	7.13	2.68	3.23
STS	19.81	23.24	68.77	75.66	-1.00	0.44	311.87	208.95	7.12	7.80	2.82	3.53
STS+S+OE	22.34	26.80	74.98	84.75	0.46	2.03	298.68	214.16	7.26	8.32	2.90	3.53
STS+S+CE	18.10	21.43	73.05	80.86	-2.62	-0.93	333.61	253.98	7.07	8.36	3.10	3.49
STS+S+8HQS	24.65	30.50	80.30	90.53	2.25	3.48	240.92	163.30	7.94	8.62	3.21	3.83
L.S.D. at 5%	0.38		0.30				2.74		0.14		0.05	
L.S.D. at 1%	0.51		0.40				3.64		0.19		0.07	
Second season												
D.W.	17.14	21.20	61.05	66.53	-6.68	-3.47	497.04	408.58	6.96	7.41	2.75	3.30
STS	23.27	24.10	70.08	76.94	-1.41	0.30	315.40	221.87	7.10	8.03	2.93	3.48
STS+S+OE	23.66	27.81	76.06	83.71	0.73	2.24	312.54	231.85	7.22	8.50	2.98	3.53
STS+S+CE	19.40	22.58	74.17	82.81	-2.56	-0.65	338.95	270.52	7.10	8.48	3.05	3.53
STS+S+8HQS	25.90	31.62	81.64	92.88	2.20	3.95	260.18	178.58	8.15	8.70	3.25	3.78
L.S.D. at 5%	0.31		0.26		0.69		1.99		0.08		0.06	
L.S.D. at 1%	0.41		0.34		0.91		2.64		0.11		0.08	

Distilled water (DW)-silver thiosalphate (STS) –Ocimum Extracts (OE) – Chamomile Extracts (CE) -8- hydroxyl quinolene sulphate (8 – HQS) – Sucrose (S)

3-2. Bacteria Counts (colonies/ ml):

Data in Table (3) demonstrate that the interaction treatments between pulsing and holding solutions highly significantly decreased number of bacteria in vase solution as compared to pulsing and holding solutions each alone. Moreover, the interaction treatment between pulsing solution of (STS + S + 8-HQS) for 12 hours and holding solution contained (sucrose + 8-HQS + citric acid) recorded highly significant decrease in number of bacteria in vase solutions as compared to other treatments under study and control during two seasons. Such effect could be attributed to that the xylem blockage that prevents water uptake into several cut flowers is mainly due to the presence of bacteria. The inclusion of antibacterial compounds (8HQC) in the vase water considerably delayed the time to wilting in astilbe cut flowers and increased vase life, (Loubaud et al., 2004). Antimicrobial compounds that delay wilting without being toxic to cut flowers include 8HQS or HQC. These compounds positively affected the length of vase life of gladiolus, gypsophila and rose. During vase life, the number of bacteria in the vase water of several cut flower species have been measured, (Van Doorn, 1997). Also, Zagory and Reid (1986) stated that addition of antimicrobial compounds to the vase water has been found to increase longevity of many cut flowers. Whereas the inclusion of a high number of bacteria in the vase water had been found to reduce longevity.

3-3. Chemical Constituents:

The results presented in Table (3) reveal that under the used interaction treatments between pulsing and holding solutions, the interaction treatments between pulsing solutions and holding solution containing (sucrose + 8-HQS + citric acid) recorded increase in anthocyanin content in the petals and total sugars percentage in the florets as compared to the pulsing and holding solutions each alone . However, the interaction treatment between pulsing solution of (STS + S + 8-HQS) for 12 hours and holding solution contained (sucrose + 8-HQS + citric acid) recorded highly significant increase in anthocyanin content in the petals and total sugars percentage in the florets as compared to the other treatments and control during two seasons. Similar results were found by Gendy (2000) on gladiolus regarding the interaction between (STS) as pulsing solution and holding solution contained (S+8HQS+CA).

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