J. Product. & Dev., 12(2): 595– 612(2007)

POSTHARVEST STUDIES ON CUT ROSE FLOWERS (*Rosa hybrida*, L. cv. First Red). 3-EFFECT OF SOME PRESERVATIVE SOLUTIONS ON FLOWER QUALITY, PHYSIOLOGICAL CHARACTERISTICS AND CHEMICAL COMPOSITION OF FRESH CUT FLOWERS

E. M. Badawy; M. M. M. Hussein and Nermeen T. Shanan
Ornamental Horticulture Department, Faculty of Agriculture, Cairo University- Egypt.

ABSTRACT

This study was carried out at the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 2005 and 2006 with the aim of investigating the effect of preservative solutions and holding periods on the quality, physiological characteristics and chemical composition of fresh rose flowers (Rosa hybrida, L. cv. First Red). The flowers were placed in jars containing one of the following preservative solutions: (1) distilled water, (2) 2% sucrose (Suc) + 200 ppm 8-hydroxy-quinoline (8-HQ) + 250 ppm citric acid (CA), (3) 2% Suc+ 200 ppm 8-HQ + 250 ppm CA + 2 mM 2-mercaptoethanol, (4) 2% Suc + 200 ppm 8-HQ + 250 ppm CA + 0.1% $Ca(NO_3)_2$, (5) 2% Suc + 200 ppm 8-HQ, (6) 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ or (7) 2% Suc + 200 ppm 8- HQ + 1 mM boric acid.

The results showed that the fresh weight of the flowers and the rate of daily absorption were decreased after the 3rd day of the holding period, while the respiration rate was decreased after the 6th day. The rate of increase in the flower diameter was decreased steadily with prolonging the holding period. On the contrary, peroxidase activity in the neck of the flower and stem base, was higher on the 12th day than on the 6th day of the holding period. The total soluble sugars contents in the petals and leaves, the anthocyanins and carotenoids contents in the petals, as well as the total chlorophylls and carotenoids contents in the leaves, were lower on the 12th day than on the 6th day of the holding period, whereas the total soluble phenols contents in the petals and leaves were higher on the 12th day than on the 6th day of the holding period.

Most of the tested preservative solutions increased the flower quality and improved physiological characteristics and chemical composition compared to distilled water (the control). The preservative solution containing 2% sucrose (Suc) + 200 ppm 8-hydroxy-quinoline (8-HQ) +2 mM 2-mercaptoethanol + 250 ppm citric acid (CA) can be recommended for use with Rosa hybrida cv. First Red flowers, since it gave the best results in terms of flower quality, physiological characteristics and chemical composition, whereas using the preservative solution containing 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ resulted in the lowest quality and unacceptable physiological characteristics and chemical composition.

Key words: *Rosa hybrida*, preservative solution, holding period, sucrose, 8-hydroxy-quinoline, 8-HQ, 2-mercaptoethanol, citric acid, $Ca(NO_3)_2$, $CuSO_4$, boric acid.

INTRODUCTION

Roses are among the major ornamental plants in many countries. Commercially, rose flowers are marketed either as potted plants or cut flowers (Figueroa *et al*., 2005). Commercial harvest of roses is usually done at the bud stage. For flower opening, large amounts of soluble carbohydrates are required for respiration and cell wall synthesis. As sugar reserves in cut rose flowers are gradually consumed, the vase life of cut roses may be thus shortened (Ichimura, 2003). Also, the short vase life is attributed partly to vascular occlusion, which constricts the water supply to the flowers (De Stigter, 1980). These occlusions are developed mainly due to bacteria. So, many researchers mentioned that preservative solutions containing sugars (such as sucrose or glucose) in combination with some germicides (such as 8-hydroxyquinoline sulfate or 8-hydroxyquinoline citrate) extended the vase life of many cut flowers including rose flowers [Ichimura (2003)].

Many investigators mentioned that some substances play an important role in extending vase life and maintaining the quality of cut flowers, when added to preservative solutions. In this respect, Michalczuk *et al.* (1989) on rose cvs. Sonia, Celica, Samantha, and Mercedes, reported that calcium nitrate promoted bud opening, while Serrano *et al.* (2001) on *Dianthus caryophyllus* cv. Master, reported that boric acid prevented the early rise in ethylene production and considerably improved vase life. Also, some chemicals were found to promote peroxidase activity in the flower necks [Kim and Lee (2002) on rose flowers], and to decrease it in the stem base [Vaslier and Van Doorn (2003) on bouvardia flowers], and that these two effects were associated with prolonged flower longevity. Van Doorn and Vaslier (2002), on *Dendranthema grandiflora* cv. Vyking, mentioned that 2-mercaptoethanol and copper sulfate inhibited peroxidase activity in the stem base, and consequently prevented vascular occlusion which inhibits water supply to the flowers.

The purpose of this study was to evaluate the physiological effects of different compounds used to formulate preservative solution for floral stems conservation, and their influence on the quality of fresh *Rosa hybrida* cv. First Red cut flowers.

MATERIALS AND METHODS

This study was carried out at the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 2005 and 2006 with the aim of investigating the effect of preservative solutions and holding periods on the flower quality, physiological characteristics and chemical constituents of fresh rose flowers (*Rosa hybrida*, L. cv. First Red).

Rose flowers (*Rosa hybrida*, L. cv. First Red) were obtained from Floramix, a commercial Farm in Kafr Hakim, Giza. On 1st March 2005 and 2006, in the first and second seasons, respectively, one hundred and eighty nine rose flowers were selected having a stem length of 80 cm and bearing four pairs of leaves on each stem. The flowers were harvested at the mature bud stage in the early morning. The flowers were pre-cooled (at 4°C for 6 hours) to remove the effect of high temperature in the field, then they were wrapped in Kraft paper in bunches, each containing 21 flower stems. The flowers were

moved under dry conditions to the laboratory (25 ± 2 ºC) within one hour, where they were un-wrapped. The stem bases were then re-cut in the air by removing about 3 cm.

The flowers were placed in jars (500 ml capacity) containing 250 ml of the following preservative solutions:

1- Distilled water (as a control)
2- 2% sucrose (Suc) + 200 ppm 8-hydroxy-quinoline (8-HQ) + 250 ppm citric acid (CA).
3- "" + "" + "" +2 mM 2-mercaptoethanol ($HSCH_2CH_2OH$).
4- "" + "" + "" + 0.1% $Ca(NO_3)_2$.
5- 2% Suc + 200 ppm 8-HQ
6- "" + "" + 100 ppm $CuSO_4$
7- "" + "" + 1 mM boric acid.

Each of the seven preservative solutions was used in three jars (replicates), with 9 flowers / jar.

Data recorded:

I – Flower quality:

- Flower longevity (number of days till wilting of petals).
- Rate of flower weight changes by determining flower fresh weight just before the beginning of the treatments, and then recording fresh weight changes every three days throughout the holding period (i.e. after 3, 6, 9, and 12 days from the beginning of the experiment). The rate of flower weight change (g /flower /day) was calculated by dividing the difference in flower weight by the total number of days from the beginning of the holding period (3, 6, 9 or 12 days).
- The rate of increase in flower diameter (cm /flower /day) was calculated by determining flower diameter at the beginning of the treatments and every three days throughout the holding period, using a Vernier caliper.

II – Physiological characteristics

- The rate of daily absorption: the absorption of the preservative solution was recorded every 3 days, from the beginning of the experiment till wilting of the petals, and the average of daily absorption rate (g/flower/day) was calculated.
- The respiration rate of flowers (ml CO_2 /g /hr) was measured every three days from the beginning of the experiment using a "Food Pack Gas Analyzer" (Sevomex Inst. Model 1450 C), according to Pesis and Ben-Arie (1984) and Lurie and Pesis (1992).
- Peroxidase activity was determined twice in the neck and stem base, on the 6^{th} and 12^{th} day from the beginning of the holding periods, using the method described by Amako *et al.* (1994).

III – Chemical compositon:

On the 6^{th} and 12^{th} days of the holding period, chemical analysis was conducted to determine the contents of total soluble sugars in fresh petals and leaves (according to Dubois *et al*., 1956), total soluble phenols in fresh petals and leaves

(according to the A.O.A.C., 1980), anthocyanins in fresh petals (according to Fuleki and Francis, 1968), total chlorophylls (a + b) in fresh leaves, and carotenoids in fresh leaves and petals (using the method described by Nornai, 1982).

This experiment was factorial (preservative solutions treatments × holding periods) conducted using a completely randomized design with three replicates. Each replicate consisted of one jar, containing 9 flowers. The data collected in both seasons were subjected to a statistical analysis of variance (ANOVA), and the means were compared using the "Least Significant Difference (L.S.D.)" test at the 5% level, as described by Little and Hills (1978). The means for the two main factors (the preservative solutions and the holding periods) were not presented separately, because of the absence of flowers receiving some of the treatment combinations (due to wilting during the holding period), which might lead to incorrect conclusions if the calculated means of the main factors were presented.

RESULTS AND DISCUSSION

I-Flower quality

1 - Flower longevity

In both seasons, placing *Rosa hybrid*a cv. First Red flowers in most of the preservative solutions significantly prolonged the longevity of the flowers as compared to that placed in distilled water, in most cases (Table 1). The only exception to this general trend was recorded with flowers placed in 2% sucrose (Suc) + 200 ppm 8-HQ + 100 ppm $CuSO_4$, which gave shorter flower longevity in both seasons, compared to that placed in distilled water. This decrease in flower longevity was significant in the second season. This effect may be due to the role of Cu^{+2}, which promoted ethylene synthesis and consequently lead to rapid senescence, as mentioned by Knee (1995) on *Petunia hybrida*. In both seasons, flowers placed in 2% sucrose + 200 ppm 8-HQ +2 mM 2-mercaptoethanol + 250 ppm citric acid (CA) gave significantly longer longevity (16.67 and 16.00 days in the first and second seasons, respectively) as compared with the other treatments. This result is in agreement with the findings of Van Doorn and Vaslier (2002) on *Dendranthema grandiflora* cv. Vyking, who reported that flowers treated with 2 mM 2-mercaptoethanol delayed wilting.

2-The rate of flower weight changes:

In both seasons, data presented in Table 2 revealed that within each preservative solution, the fresh weight of flowers was increased till the 3rd day, in most cases. Similar results were obtained by Mwangi and Bhattacharjee (2003) on cut roses cv. Noblesse, who reported that on the 3rd day in the vase, the fresh weight of cut flowers increased over the initial value irrespective of the treatment. The data in Table 2 also showed that the rate of flower weight change decreased steadily after the 3rd day. This trend is in agreement with conclusions reached by Faragher (1986) on *Telopea speciosissima*, who found that increasing vase life was accompanied by a slow rate of reduction in flower and bract fresh weight. Three exceptions to this trend

were recorded with flowers placed in distilled water, 2% Suc + 200 ppm 8-HQ or 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ which showed a decrease in fresh weight of flowers on the 3rd day, as compared to the initial weight. Such result is in agreement with the findings of Meeteren *et al.* (2001) on *Dendranthema grandiflora*, who reported that $CuSO_4$ extremely decreased fresh weight of chrysanthemum within the 7 days of the experiment.

Table 1: Effect of preservative solutions on the longevity (days) of fresh rose flowers (*Rosa hybrida* cv. First Red) during the 2005 and 2006 seasons.

Preservative solutions		Flower longevity (days)	
		(2005)	(2006)
Distilled water		6.33	7.00
2% Suc + 200 ppm 8-HQ + 250 ppm CA	——	12.00	12.33
	+ 2 mM 2-mercaptoethanol	16.67	16.00
	+ 0.1 % $Ca(NO_3)_2$	12.67	13.00
2% Suc + 200 ppm 8-HQ	———	10.00	10.00
	+ 100 ppm $CuSO_4$	6.00	5.00
	+ 1 mM boric acid	13.67	14.00
L.S.D$_{(5\%)}$		**0.95**	**1.45**

Table 2: Effect of preservative solutions and holding periods on the rate of flower weight changes (g/ flower / day) and the rate of increase in the flower diameter (cm/flower/day) of fresh rose flowers (*Rosa hybrida* cv. First Red) during the 2005 and 2006 seasons.

Presevative Solutions (P)		Holding periods (H), day							
		(2005)				(2006)			
		3	6	9	12	3	6	9	12
		Rate of flower weight changes							
Distilled water		-0.27	-0.47	—	—	-0.41	-0.69	—	—
2% Suc + 200 ppm 8-HQ + 250 ppm CA	——	+0.61	+0.31	-0.29	-0.41	+1.05	+0.94	-0.68	-0.56
	+ 2 mM 2-mercaptoethanol	+0.89	+0.82	-0.07	-0.11	+1.49	+1.27	-0.07	-0.27
	+ 0.1 % $Ca(NO_3)_2$	+0.68	+0.46	-0.17	-0.29	+1.18	+0.88	-0.47	-0.45
2% Suc + 200 ppm 8-HQ	——	-0.23	-0.30	-0.29	—	-0.22	-0.55	-0.69	——
	+ 100 ppm $CuSO_4$	-0.38	-0.49	—	—	-0.48	-0.80	——	——
	+ 1 mM boric acid	+0.84	+0.55	-0.09	-0.19	+1.16	+1.10	-0.12	-0.38
		Rate of increase in the flower diameter							
Distilled water		0.11	0.08	---	----	0.16	0.13	----	----
2% Suc + 200 ppm 8-HQ + 250 ppm CA	——	0.43	0.32	0.29	0.16	0.33	0.30	0.24	0.25
	+ 2 mM 2-mercaptoethanol	0.79	0.74	0.51	0.46	0.67	0.59	0.50	0.37
	+ 0.1 % $Ca(NO_3)_2$	0.58	0.37	0.32	0.26	0.42	0.38	0.32	0.28
2% Suc + 200 ppm 8-HQ	——	0.38	0.26	0.15	---	0.22	0.20	0.16	---
	+ 100 ppm $CuSO_4$	0.15	0.10	-----	----	0.18	0.15	---	-----
	+ 1 mM boric acid	0.62	0.56	0.41	0.39	0.53	0.47	0.38	0.32
LSD (5%) P x H		0.05				N.S.			

Flowers placed in a solution containing 2% Suc + 2 mM 2-mercaptoethanol + 200 ppm 8-HQ + 250 ppm CA gave the highest increase in flower weight on the 3rd and 6th days of the holding period, as compared to the values recorded with flowers placed with other preservative solutions. This treatment also gave the lowest rate of flower weight loss on the 9th and 12th days of the holding period, as compared to the values recorded with surviving flowers placed in other preservative solutions. On the other hand, the highest rate of weight loss was recorded with flowers placed in the solution containing 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ in the 3rd and 6th days of the holding period, as compared to the other values recorded with the other preservative solutions before wilting.

3-The rate of increase in the flower diameter :

The rate of increase in the flower diameter was significantly affected by the interaction between preservative solutions and holding periods in the first season only (Table 2). In both seasons, within each preservative solution, the rate of increase in the flower diameter decreased steadily with prolonging the holding periods (in most cases).

On the 3rd and 6th days of the holding periods (in both seasons), the rate of increase in the flower diameter was higher in the flowers placed in different preservative solutions as compared to the flowers placed in distilled water. This increase in the diameter of the flowers held in different preservative solutions is in agreement with results obtained by Michalczuk *et al*. (1989), who reported that calcium applied to cut rose flowers (cvs. Sonia, Celica, Samantha, and Mercedes), mainly as Ca $(NO_3)_2$ at a concentration of 0.25% to a preservative solution containing 2% sucrose + 200 ppm 8-HQ promoted bud opening compared with distilled water, and Kumar *et al.* (2006) on *Polianthes tuberosa* flowers, who reported that boric acid at 225 ppm and citric acid at 300 ppm were effective in increasing flower diameter and floret opening of the cut spike, as compared with distilled water. Within each holding period, placing the flowers in a solution containing 2% Suc + 200 ppm 8- HQ + 2 mM 2-mercaptoethanol + 250 ppm CA resulted in the highest rate of increase in flower diameter, as compared to values recorded with the other preservative solutions. On the 3rd and 6th days, the lowest rate of increase in flower diameter was recorded with flowers placed in distilled water. This result is in agreement with that found by Bhattacharjee (1994) on *Rosa hybrida*, who reported that distilled water gave the lowest increase in the flower diameter, compared with values recorded with flowers placed in preservative solution.

II-Physiological characteristics

1-The rate of daily absorption

The rate of daily absorption was significantly affected by the interaction between the effects of vase solutions and holding periods (Table 3). Within each preservative solution, the rate of daily absorption was significantly decreased with prolonging holding periods (in most cases). This result is in agreement with the findings of Faragher (1986) on *Telopea speciosissima*, Pascale and Viggiani (1998)

on *Godetia grandiflora* cvs. Grace Red and Grace Rose, Chungwei *et al*. (2002) on cut roses cv. Grand Gala, and Hettiarachchi and Balas (2003) on *Codiaeum variegatum*, who found that increasing vase life was accompanied with a decrease in water uptake.

Table 3: Effect of preservative solutions and holding periods on the rate of daily absorption (g/flower/day) and the respiration rate (ml CO_2/g/hr) of rose flowers (*Rosa hybrida* cv. First Red) during the 2005 and 2006 seasons.

Preservative solutions (P)		Holding periods (H), day							
		(2005)				(2006)			
		3	6	9	12	3	6	9	12
		Rate of daily absorption							
Distilled water		9.51	6.60	----	----	10.63	7.34	----	----
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	16.06	13.55	10.09	7.78	17.63	14.30	12.33	9.24
	+ 2 mM 2-mercaptoethanol	18.24	17.75	14.66	10.89	20.72	18.36	15.40	11.51
	+ 0.1 % $Ca(NO_3)_2$	16.72	14.70	11.23	8.61	18.74	16.59	11.22	10.03
2% Suc + 200 ppm 8-HQ	———	15.33	12.21	9.60	----	15.71	13.01	11.81	---
	+ 100 ppm $CuSO_4$	8.40	5.80	----	----	9.27	6.05	-----	-----
	+ 1 mM boric acid	17.23	15.98	12.01	9.91	19.09	17.74	13.19	10.85
LSD (5%) P x H		1.16				1.23			
		Respiration rate							
Distilled water		70.95	78.94	---	----	73.06	80.54	----	---
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	80.51	140.16	119.93	39.48	85.89	143.52	127.49	48.02
	+ 2 mM 2-mercaptoethanol	92.97	150.76	140.34	58.80	99.87	168.30	143.52	70.90
	+ 0.1 % $Ca(NO_3)_2$	85.92	145.04	124.74	42.91	90.96	156.30	132.72	52.84
2% Suc + 200 ppm 8-HQ	———	79.86	137.19	108.07	---	84.05	131.64	114.82	----
	+ 100 ppm $CuSO_4$	74.80	86.28	----	----	79.14	82.63	---	----
	+ 1 mM boric acid	89.76	147.34	130.80	54.61	96.05	160.53	136.48	65.63
LSD (5%) P x H		7.09				6.83			

On the 3rd and 6th days of the holding period, most of the preservative solutions significantly increased the rate of daily absorption by rose flowers, as compared to that recorded with flowers placed in distilled water. In both seasons, rose flowers placed in solution containing 2% sucrose + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA resulted in a significantly higher daily absorption rate throughout the holding period, as compared to the values recorded with flowers placed in other preservative solutions (in most cases). Such results were explained by Van Doorn and Cruz (2000), who reported that 2-mercaptoethanol prevented bacterial growth in the stem ends (thus reducing blockage of the xylem conduits), by reducing the pH to below 5. On the other hand, in most cases, flowers held in a solution containing 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ gave significantly lower values for the rate of daily absorption on the 3rd and 6th days before wilting, as compared to the values recorded with flowers placed in the other preservative solutions. This result is in agreement with Kim *et al.* (1996) on *Ustilago maydis*, who reported that the rate of water uptake was lower in flowers treated with copper sulfate.

2-Respiration rate

In both seasons, the respiration rate was significantly affected by the interaction of preservative solutions and holding periods (Table 3). On the 6th day of the holding period, the flowers placed in most of the preservative solutions had significantly higher respiration rate, as compared to that recorded on the 3rd day of the holding period. After that, the respiration rate was significantly decreased steadily in the surviving flowers till the 12th day. These results are in agreement with the findings of Collier (1997) on tulip tepals and *Alstroemeria* petals, who found that respiration rate was decreased during senescence, and Bhattacharjee and Pal (1999), who reported that the respiration rate of rose flowers was sharply increased during flower development and petal expansion stages, and declined during senescence, regardless of the effect of preservative solutions.

In both seasons, on the 3rd and 6th days of the holding periods, the respiration rate was significantly higher in the flowers placed in different preservative solutions, as compared to the values recorded with flowers placed in distilled water (in most cases). This result is in agreement with conclusions reached by Pal *et al*. (2003) on cut roses cv. First Red, they reported that addition of sucrose and HQC in the holding solution helped in maintaining the overall quality characteristics of cut flowers, including the respiration rate. Also, Viggiani and Pascale (1998) on *Rosa hybrida* cvs. Dallas and Maya, reported that the preservative solution increased respiration rate by providing an additional source of carbon, while Pascale and Viggiani (1998) on *Godetia grandiflora*, reported that the respiration rate decreased during senescence of cut flowers, and was increased by keeping them in a preservative solution.

Placing the flowers in a solution containing 2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA resulted in a significantly higher respiration rate on the 3rd and 6th days, compared with most of the other preservative solutions used. Also, this treatment gave higher values on the 9th and 12th days, compared to plants surviving in other preservative solutions. It is worth mentioning that this solution extended vase life of cut rose flowers from 6.33 and 7.00 days in distilled water, in the first and second seasons, respectively, to 16.67 and 16.00 days in the two seasons, respectively.

3- Peroxidase activity in the neck and stem base

Data presented in Table 4 showed that, in both seasons, the peroxidase (POD) activity in the neck and stem base of the flowers was significantly affected by the interaction between preservative solutions and holding periods. Within each of the preservative solutions, it was evident that, in most cases, the peroxidase activity in the neck and stems of the surviving flowers was significantly higher on the 12th day than on the 6th day of the holding period. These results are in agreement with the findings of Xue and Lin (1999) on rose flowers, and Liao *et al.* (2003) on gerbera flowers, they reported that peroxidase activity increased rapidly during vase holding.

Table 4: Effect of preservative solutions and holding periods on the peroxidase activity (units/mg protein) in the neck and stem base of fresh rose flowers (*Rosa hybrida* cv. First Red) during the 2005 and 2006 seasons.

Preservative solutions (P)		Holding periods (H), day							
		In the neck				In the stem base			
		(2005)		(2006)		(2005)		(2006)	
		6	12	6	12	6	12	6	12
Distilled water		12.92	-----	18.34	-----	10.47	-----	12.60	-----
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	11.54	12.99	13.05	16.44	7.48	13.99	10.43	17.43
	+ 2 mM 2-mercaptoethanol	13.94	15.97	19.82	25.03	4.01	5.16	6.03	7.21
	+ 0.1 % $Ca(NO_3)_2$	11.77	13.45	14.96	17.66	4.96	7.27	9.44	11.89
2% Suc + 200 ppm 8-HQ	———	10.50	-----	11.63	-----	7.07	-----	10.07	-----
	+ 100 ppm $CuSO_4$	6.86	-----	11.23	-----	9.40	-----	11.48	-----
	+ 1 mM boric acid	12.46	13.53	16.23	22.77	4.70	6.70	8.69	10.24
LSD (5%) P x H		1.19		1.69		1.15		1.27	

On the 6th day of the holding period, it was evident that rose flowers placed in most of the preservative solutions had significantly lower peroxidase activity in the neck and the stem base, compared to flowers placed in distilled water.

On the other hand, flowers placed in 2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA showed significantly higher peroxidase activity in the flower necks on the 6th and 12th days of the holding periods, as compared to that placed in the other preservative solutions (in most cases). This increase in the peroxidase activity in the flower necks was associated with the highest longevity (as mentioned in Table 1). The benefit role of peroxidase activity in the flower neck is to catalyze the separation reaction that leads to polymerization of aromatic alcohols to lignin (Salisbury and Ross, 1992). A similar conclusion was reached by Kim and Lee (2002) on rose flowers, who reported that the preservative solutions which increased longevity resulted in higher peroxidase activity in the neck of the flower.

In most cases, the flowers placed in 2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA showed significantly lower peroxidase activity in the stem base of rose flowers on the 6th and 12th days of the holding period, as compared to flowers held in the other preservative solutions. This result may be attributed to the role of 2-mercaptoethanol as an inhibitor of peroxidase activity in the stem base of rose flowers, and consequently prevents the development of a physiological blockage, which mainly occurs in the lowermost 5 cm of the stem. This occlusion apparently involves the activities of peroxidase, as reported by Van Doorn and Vaslier (2002) on *Dendranthema grandiflora* cv. Vyking, and Vaslier and Van Doorn (2003) on bouvardia flowers. The favourable effect of this treatment on the longevity of rose flowers is presented in Table 1.

Data presented in Table 4, also revealed that, in most cases, peroxidase activity in the upper sections (in the neck of rose flowers) was higher than in the lower sections (base of the flower stem). This result is in agreement with the findings of Liao *et al*. (2003) on cut gerbera flowers.

III-Chemical constituents

1-Total soluble sugars content in the petals and leaves

The content of total soluble sugars in the petals and leaves of rose flowers was significantly affected by the interaction between preservative solutions and holding periods (Table 5). In both seasons, the total soluble sugars content in the petals and leaves of flowers surviving till the 12th day was significantly lower than values recorded on the 6th day (in most cases). This result is in agreement with the findings of Mwangi *et al*. (2003) on cut rose cv. Golden Gate, they reported that prolonged vase life was associated with low total soluble sugars in the petals. Also, Singh *et al*. (2004), on rose cv. Queen Elizabeth, reported that the sugar content decreased after 6 days in all treatments.

On the 6th day, in both seasons, total soluble sugars content in the petals and leaves of flowers was significantly increased in flowers placed in most of the tested preservative solutions, as compared to the values recorded with flowers placed in distilled water. The explanation of these results was presented by Salisbury and Ross (1992), who mentioned that the increase in the total soluble sugars content of flowers held in preservative solutions may be attributed to the promotion of the transfer of sugars into the flower cells with the help of energy produced by respiration (which was increased by using the preservative solutions, as previously mentioned). On the 6th day, placing rose flowers in a solution containing 2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA resulted in a significantly higher total soluble sugars content in the petals and leaves, as compared to most of the other treatments. Also, this treatment proved to be the best treatment because of giving a higher total soluble sugars content in the petals and leaves on the 12th day, compared to values recorded on surviving flowers held in other solutions. These results indicated that extended vase life was associated with increasing total soluble sugars content in the petals and leaves (Tables 1 and 5). Similar conclusions were reached by Bhattacharjee and De (1998) on rose flowers cv. Raktagandha, and Kim and Lee (2002) on rose flowers cv. 'First Red, they found that rose flowers having long vase life maintained high total sugar contents at and after harvest. This may indicate that vase life and carbohydrate supply are closely correlated. Thus, it is clear that supplementing the preservative solution with materials needed for carbohydrate metabolism during flower growth and development is essential for extending vase life.

Table (5): Effect of preservative solutions and holding periods on the total soluble sugars (g/100g F. W.) and total soluble phenols (mg/g F.W.) contents in the petals and leaves of fresh rose flowers (*Rosa hybrida* cv. First Red) during the 2005 and 2006 seasons.

Preservative solutions (P)		Holding periods (H), day							
		(2005)		(2006)		(2005)		(2006)	
		6	12	6	12	6	12	6	12
		Petals				Leaves			
		Total soluble sugars							
Distilled water		2.50	----	3.32	----	2.12	------	2.17	-----
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	3.04	2.62	4.00	3.61	2.30	1.86	3.15	1.29
	+ 2 mM 2-mercaptoethanol	3.50	3.18	4.21	4.03	2.70	2.10	3.84	3.07
	+ 0.1 % $Ca(NO_3)_2$	3.20	2.89	4.40	3.80	2.44	1.49	3.23	0.97
2% Suc + 200 ppm 8-HQ	———	3.10	----	4.09	-----	2.20	-----	2.73	----
	+ 100 ppm $CuSO_4$	2.82	-----	3.52	------	2.06	-----	1.96	------
	+ 1 mM boric acid	3.38	2.94	3.39	3.91	2.64	2.05	3.54	2.32
LSD (5%)									
P x H		**0.29**		**0.47**		**0.39**		**0.36**	
		Total soluble phenols							
Distilled water		5.68	----	7.52	----	4.84	----	6.84	----
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	5.30	5.64	7.30	7.52	5.00	5.32	7.12	7.55
	+ 2 mM 2-mercaptoethanol	5.92	6.76	7.44	8.03	5.70	6.51	7.49	8.84
	+ 0.1 % $Ca(NO_3)_2$	5.48	5.80	7.11	7.80	5.25	5.52	7.26	7.78
2% Suc + 200 ppm 8-HQ	———	4.92	-----	8.00	----	4.52	----	6.63	----
	+ 100 ppm $CuSO_4$	5.64	-----	7.43	----	6.20	-----	8.94	-----
	+ 1 mM boric acid	5.60	6.58	7.32	7.98	5.46	5.99	7.32	8.49
LSD (5%)									
P x H		**0.34**		**0.55**		**0.31**		**0.50**	

Generally, the presence of $CuSO_4$ in the vase solution was unfavorable, as it resulted in the lowest total soluble sugars content in the leaves on the 6th day (2.06 and 1.96 g/100 g fresh weight in the first and second seasons, respectively) before wilting. Also, flowers placed in distilled water gave a lower total soluble sugars content in petals on the 6th day before wilting, as compared with most of the other treatments. These results are in agreement with the findings of Kaltaler and Steponkus (1976) they noted that the petal sugars decreased slightly in roses maintained in distilled water.

In general, the petals had a higher total soluble sugars content than leaves. This result is in agreement with the findings of Kim *et al*. (2005) on *Lilium* spp., and De *et al*. (1996) on *Rosa hybrida* cv. Super Star.

2-Total soluble phenols content in the petals and leaves

The total soluble phenols content in the petals and leaves of rose flowers was significantly affected by the interaction between preservative solutions and holding periods (Table 5). Within each preservative solution, rose flowers which survived till the 12th day of the holding period had significantly higher total soluble phenols

contents in petals and leaves, as compared to the values recorded on the 6th day of vase life (in most cases). These results are in agreement with Mwangi *et al*. (2003), on cut rose cv. Golden Gate, who reported that total soluble phenols was increased during flower development and senescence.

On the 6th day of the holding period, in both seasons, the flowers placed in most of the preservative solutions had lower total soluble phenols content in the petals, and higher total soluble phenols content in the leaves, as compared to the flowers placed in distilled water.

In both seasons, the flowers placed in 2 % Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA gave higher total soluble phenols content in the petals on the 6th day of the holding period, compared to the flowers placed in the other preservative solutions. Also, flowers held in this preservative solution gave higher values on the 12th day, compared to the flowers surviving in other preservative solutions (in most cases).

On the 6th day of the holding period, the flowers placed in 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ had a significantly higher total soluble phenols content in the leaves, compared to the flowers held in the other preservative solutions, followed by the flowers placed in the solution containing 2 % Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA, with significant differences between them. On the 12th day of the holding period, the flowers placed in 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ were absent because of wilting, whereas flowers placed in the solution containing 2 % Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA gave significantly higher total soluble phenols, as compared to the surviving flowers in the other solutions.

In the first season, rose petals had higher contents of total soluble phenols than the leaves, in most cases. This result is in agreement with the findings of Kim and Lee (2002) on rose flowers.

3-Pigments in the petals (anthocyanins and carotenoids content)

Data presented in Table 6 showed that the anthocyanins and carotenoids contents were significantly affected by the interaction between the preservative solutions and holding periods. Within each preservative solution, the surviving flowers had significantly lower anthocyanins and carotenoids contents in the petals on the 12th day of the holding period, as compared to the values recorded on the 6th day. Similar results were obtained by Solecka and Goaszewska (1985) on cut rose flowers, they found that the anthocyanins content decreased with senescence, and Faragher (1986) on *Telopea speciosissima*, who found that during vase life the anthocyanins content of the flowers decreased. Also, Ferrante *et al*. (2004) on cut stock flowers, who found that total carotenoids drastically decreased at the end of vase life.

On the 6th day, it was evident that placing the flowers in the different solutions resulted in significant increase in the anthocyanins and carotenoids contents in the petals, as compared to placing the flowers in distilled water (in most cases). These results are in agreement with the findings of Lukaszewska (1980), who reported that cut carnation flowers placed in a preservative solution had higher anthocyanins content than control flowers.

Table (6): Effect of preservative solutions and holding periods on anthocyanins (g/100 g. F.W.) and carotenoids (mg/100 g. F.W.) contents in petals, as well as total chlorophylls (mg/100 g. F.W.) and carotenoids (mg/100 g. F.W.) content in leaves of fresh rose flowers (*Rosa hybrida* cv. First Red) during the 2005 and 2006 seasons.

Presevative solutions (P)		Holding periods (H), day							
		(2005)		(2006)		(2005)		(2006)	
		6	12	6	12	6	12	6	12
Petals									
		Anthocyanin content				**Carotenoids content**			
Distilled water		0.22	---	0.16	---	35.21	----	39.67	----
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	0.32	0.25	0.52	0.35	50.49	41.30	68.04	44.97
	+ 2 mM 2-mercaptoethanol	0.70	0.36	0.75	0.55	94.08	48.01	90.62	61.56
	+ 0.1 % $Ca(NO_3)_2$	0.40	0.30	0.67	0.46	56.00	43.26	71.54	50.07
2% Suc + 200 ppm 8-HQ	———	0.25	---	0.26	---	42.28	----	55.37	----
	+ 100 ppm $CuSO_4$	0.30	---	0.42	---	43.40	-----	43.83	-----
	+ 1 mM boric acid	0.63	0..31	0.72	0.50	88.48	46.26	89.74	55.64
LSD (5%) P x H		**0.05**		**0.07**		**4.53**		**5.05**	
Leaves									
		Total chlorophylls				**Carotenoids content**			
Distilled water		43.55	----	31.29	----	18.30	-----	26.87	-----
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	51.08	36.40	51.69	40.75	24.00	19.46	31.80	24.00
	+ 2 mM 2-mercaptoethanol	73.07	51.61	89.40	73.61	32.40	25.87	44.57	40.96
	+ 0.1 % $Ca(NO_3)_2$	56.22	39.88	65.45	48.14	25.20	21.94	35.00	27.66
2% Suc + 200 ppm 8-HQ	———	48.89	----	41.14	----	21.60	-----	27.09	-----
	+ 100 ppm $CuSO_4$	43.18	----	27.84	----	19.00	-----	30.77	-----
	+ 1 mM boric acid	69.79	44.66	74.25	58.49	27.62	23.35	41.67	30.82
LSD (5%) P x H		**4.30**		**5.60**		**1.69**		**3.86**	

In most cases, the flowers placed in the solution containing 2% Suc + 200 ppm 8-HQ+2 mM 2-mercaptoethanol+250 ppm CA had significantly higher anthocyanins and carotenoids contents in the petals on the 6th of the holding period, as compared to the flowers placed in the other preservative solutions. Also, this treatment gave higher values on the 12th day, as compared to the values recorded on flowers survived in the other preservative solutions.

4-Pigments in the leaves (total chlorophylls and carotenoids content)

Data presented in Table 6 showed that the total chlorophylls (a + b) and carotenoids contents were significantly affected by the interaction between preservative solutions and holding periods. On the 12th day of the holding period, within each preservative solution, the surviving rose flowers had significantly lower total chlorophylls (a+b) and carotenoids contents in the leaves, as compared to the values recorded on the 6th day, in most cases. Such results are in agreement with the findings of Skutnik *et al*. (2001) on *Zantedeschia aethiopica*, who reported that after harvest, chlorophyll content of the leaves was decreased with time.

On the 6th day of the holding period, in both seasons, the total chlorophylls (a+b) and carotenoids contents in the leaves of rose flowers placed in the preservative solutions were significantly higher than those obtained in the leaves of the flowers placed in distilled water (in most cases). This favourable effect of preservative solutions on the total chlorophylls (a + b) and carotenoids contents is in agreement with the findings of Behera (1993) on carnation cv. White Sim.

Within each holding period, the flowers placed in 2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA had significantly higher total chlorophylls (a + b) and carotenoids contents on the 6th day, as compared to flowers placed in the other preservative solutions (in most cases). On the 12th day, this treatment also gave generally higher values than those recorded in flowers surviving in other preservative solutions.

Recommendation: From the above results, it can be recommended that *Rosa hybrida*, L. cv. First Red flowers could be placed in a preservative solution containing 2% sucrose (Suc) + 200 ppm 8-hydroxy-quinoline (8-HQ) +2 mM 2-mercaptoethanol + 250 ppm citric acid (CA) to improve flower quality, physiological characteristics as well as chemical composition of the flowers.

REFERENCES

Amako, A.; G.C. Ghen and K. Asada (1994). Separate assays specific for the ascorbate peroxidase and guaiacol peroxidase and for the chloroplastic and cytosolic isozyme of ascorbate peroxidase in plants. *Plant Cell Physiology*, **35**: 497-507.

A.O.A.C (1980). Association of Official Analytical Chemists. *Official Methods of Analysis.* 832-849. Washington. D.C.USA.

Behera, P. K. (1993). Senescence in cut leafy flowering shoot: role of sucrose. *Plant Physio. and Biochem.*, **20**(1): 59-62.

Bhattacharjee, S.K. (1994). Postharvest life of cut roses as affected by varietal differences. *South Indian Hort*., **42**(5): 331.

Bhattacharjee, S.K. and L.C. De (1998). Influence of pulsing with different chemicals on postharvest life and biochemical constituents of cut roses. *PKV Research J.,* **22** (2): 183-187.

Bhattacharjee, S.K. and M. Pal (1999). Post-harvest life, quality and respiration rate of rose cultivars. *J. Maharashtra Agri. Univ*., **24**(1): 28-30.

Chungwei, L.; Y.C. Chen; Y.C. Wang; R.S. Lin and C.W. Cheng (2002). The effects on quality of rose cut flowers due to vibration. *J. Agric. and Forestry*; 51 (4): 65-86.

Collier, D.E. (1997). Changes in respiration, protein and carbohydrates of tulip tepals and *Alstroemeria* petals during development. *J. Plant Physiol*., **150**(4): 446-451.

De, L.C.; S.R. Chatterjee; T.V.R. Nair and S.K. Bhattacharjee (1996). Influence of bud opening solutions on the biochemical changes occurring in cut roses of varying maturity. *Plant Physiol. & Biochem.*, **23**(2):173-178.

De Stigter, H.C.M. (1980). Water balance of cut and intact Sonia rose plants. *Z. Pflanzenphysiol.,* **99**: 131–140.

Dubois, M.; F. Smith; K.A. Gilles; J.K. Hamilton and P.A. Rebers (1956). Colorimetric method for determination of sugars and related substances. *Annal. Chem.*, **28** (3): 350-356.

Faragher, J.D. (1986). Post-harvest physiology of waratah inflorescences (*Telopea speciosissima*, Proteaceae). *Scientia Horticulturae*, **28**(3): 271-279.

Ferrante, A.; F. Tognoni; A. Mensuali-Sodi and G. Serra (2004). Treatment with thidiazuron for preventing leaf yellowing in cut tulips and chrysanthemum. *Acta Hort.*, **624**: 357-360.

Figueroa, I.; M.T. Colinas; J. Mejía and F. Ramírez (2005). Postharvest Physiological Changes in Roses of Different Vase Life. Experiments in Plant Physiology. Pp.245. Van Nostrand Company, New York, USA.

Fuleki, T. and F.J. Francis (1968). Quantitative methods for anthocyanins extraction and determination of total anthocyanins in cranberries. *J. Food Sci.,* **33**: 72- 77.

Hettiarachchi, M. P. and J. Balas (2003). Effects of hydration solutions on postharvest quality of croton (*Codiaeum variegatum* (L.) A. Juss. 'Excellent') after shipment. *J. Postgraduate Instit. Agric.,* University of Peradeniya, Peradeniya, Sri Lanka., **15:** 327-330.

Ichimura, K. (2003). Shortage of soluble carbohydrates is largely responsible for short vase life of cut 'Sonia' rose flowers. *J. Japan Soc. Hort. Sci*., **72,** 292–298.

Kaltaler, R.E.L. and P.L. Steponkus (1976). Factors affecting respiration in cut roses. *J. Amer. Soc. Hort. Sci*., **101**(4): 353-354.

Kim J.H.; A.K. Lee and J.K. Suh (2005). Effect of certain pre-treatment substances on vase life and physiological character in *Lilium* spp. *Acta Hort*., **673** (1):307-314.

Kim, S.H.; J. W. Kronstod and B.E. Ellis (1996). Purification and characterization of phenylalanine ammonia-lyase from *Ustilago maydis*. Phytochemistry, 43: 51-57.

Kim, Y. and J. Lee (2002). Changes in lignin content, phenylalanine ammonia lyase activity, and peroxidase activity as affected by bent neck and senescence of cut rose flowers. *J. Korean Soc. Hort. Sci.,* **43**(2):208-212.

Knee, M. (1995). Copper reverses silver inhibition of flower senescence in *Petunia hybrida*. *Postharvest Biol. and Technol*., **6** (1): 121-128.

Kumar, S.; O.P. Singh; B. Singh and S.K. Lodhi (2006). Improvement of shelf life of cut tuberose through chemical treatment. *Plant Archives*, **6**(1): 353-355.

Liao, L.J.; Y.H. Lin; K.L. Huang; W.S. Chen; L.L. Cheng; Y.H. Peng and Q.S. Ye (2003). Neck-bending phenomena in cut gerbera flower. *Acta Horticulture Sinica,* **30**(1): 110-112.

Little, T.M. and F.J. Hills (1978). *Agricultural Experimentation – Design and Analysis.* John Wiley & Sons, Inc., New York, USA, pp. 53-63.

Lukaszewska, A. (1980). Effect of sucrose in a holding solution on some processes associated with ageing of cut carnations. *Acta Agrobotanica,* **33**(2): 229-237.

Lurie, S. and E. Pesis (1992). Effect of acetaldehyde and anaerobiosis as postharvest treatment on the quality of peaches and nectarines. *Postharvest Biol. and Technol.,* **1**(2): 317-326.

Meeteren, U.; A. Gelder; W. Ieperen and C. Slootweg (2001). Should we reconsider the use of deionized water as control vase solutions. *Acta Horticulturae,* **543**: 257-262

Michalczuk, B.; D.M. Goszczynska; R.M. Rudnicki, and A.H. Halevy (1989). Calcium promotes longevity and bud opening in cut rose flowers. *Israel J. Botany*; **38**(4): 209-215.

Mwangi, M. and S.K. Bhattacharjee (2003). Influence of pulsing and dry cool storage on postharvest life and quality of 'Noblesse' cut roses. *J. Indian Soc. Ornam. Hort*., **6**(2): 126-129.

Mwangi, M.; S.R. Chatterjee and S.K. Bhattacharjee (2003). Changes in the biochemical constituents of 'Golden Gate' cut rose petals as affected by precooling with ice-cold water spray, pulsing and packaging. *J. Plant Biol.,* **30**(1): 95-97.

Nornai, R. (1982). Formula for determination of chlorophyll pigments extracted with N.N. dimethyl formamide. *Plant Physiol.,* **69**: 1371-1381.

Pal, R.K.; M. F. Lahiji and S.K. Roy (2003). Influence of storage environment, 8-HQC and sucrose on post harvest quality of 'First Red' cut rose. *J. Indian Soc. Ornam. Hort.,* **6**(2): 130-133.

Pascale, S. and S. Viggiani (1998). Water relations and gas exchanges of cut *Godetia* flowers during vase life. Advances in Hort. Sci., 12(3): 153-157.

Pesis, E. and R. Ben-Arie (1984). Involvement of acetaldehyde and ethanol accumulation during induced deastringency of persimmon fruits. *J. Food Sci.,* **49:** 896-899.

Salisbury, F. B. and C. W. Ross (1992). *Plant Physiology*. 4th Ed., Wadsworth Publishing Company, California, USA, pp. 158 – 159 and 322 - 323.

Serrano, M.; P.M. Amoros; P. M.Teresa; M.M.C. Martinez and F. Romojaro (2001). Preservative solutions containing boric acid delay senescence of carnation flowers. *Postharvest Biol. and Technol*., **23**(2):133-142.

Singh, A.K.; P.J. Singh and R. Kumar (2004). Effect of some chemicals on keeping quality of cut roses. *Advances in Hort. Sci.,***18**(4): 161-167.

Skutnik, E.; A. Lukaszewska, M. Serek; and J. Rabiza (2001). Effect of growth regulators on postharvest characteristics of *Zantedeschia aethiopica*. *Postharvest Biol. and Technol.,* **21**(2): 241-246.

Solecka, M. and A. Goaszewska (1985). Quantitative changes in anthocyanins during fading of roses. Prace Instytutu Sadownictwa i Kwiaciarstwa w Skierniewicach, *B (Rosliny Ozdobne),* **10**: 53-58.

Van Doorn, W.G. and N. Vaslier (2002). Wounding-induced xylem occlusion in stems of cut chrysanthemum flowers: roles of peroxidase and cathechol oxidase. *Postharvest Biol. and Technol*., **26**(3): 275-284.

Van Doorn, W.G. and P. Cruz (2000). Evidence for a wounding induced xylem occlusion in stems of cut chrysanthemum flowers. *Postharvest Biol. Technol*., **19**(1): 73-83.

Vaslier, N. and W.G. Van Doorn, (2003). Xylem occlusion in bouvardia flowers: evidence for a role of peroxidase and cathechol oxidase. *Postharvest Biol. and Technol.,* **28**(3): 231-237.

Viggiani, S. and S. Pascale (1998). Influence of fluoride and preservative treatments on cut roses during vase life. *Italus Hortus*, **5**(5/6): 52-56.

Xue, Q.H. and R. Lin (1999). Senescence of China rose cut-flower and its relationships to moisture content, lipid peroxidation and protective enzyme activity. *J. Fujian Agric. Univ*., **28**(3): 304-308.

دراسات ما بعد الحصاد على أزهار الورد المقطوفة (*Rosa hybrida*, L. cv. First Red)
٣- تأثير بعض محاليل الحفظ على جودة الزهرة والصفات الفسيولوجية والمحتويات الكيماوية للأزهار الطازجة.

السعدى محمد بدوى – محمد موسى محمد حسين – نرمين طه شنن.
قسم بساتين الزينة – كلية الزراعة – جامعة القاهرة – مصر

أجريت هذه الدراسة بقسم بساتين الزينة ، كلية الزراعة، جامعة القاهرة، خلال الموسمين ٢٠٠٥ و٢٠٠٦ بهدف دراسة تأثير محاليل الحفظ على جودة الزهرة والصفات الفسيولوجية والمحتويات الكيميائية لأزهار الورد ***(Rosa hybrida*, L. cv. First Red)** الطازجة. فقد تم وضع قواعد الأزهار في محاليل حفظ تشمل:

١- ماء مقطر (معاملة المقارنة).
٢- ٢% سكروز + ٢٠٠ جزء في المليون ٨ - هيدروكسى كينولين + ٢٥٠ جزء في المليون حـامض ستريك.
٣- "" + "" + "" +٢ مللى مولر ٢-ميركابتوإيثانول.
٤- "" + "" + "" + ٠.١% نترات كالسيوم.
٥- ٢% سكروز + ٢٠٠ جزء فى المليون ٨ - هيدروكسى كينولين.
٦- "" + "" + ١٠٠ جزء فى المليون كبريتات نحاس.
٧- "" + "" + ١ مللى مولرحمض بوريك.

وقد أظهرت النتائج:

انخفاض كل من الوزن الطازج ومعدل الامتصاص اليومي بعد اليوم الثالث، وكذلك معدل التنفس بعـد اليوم السادس وأيضاً معدل الزيادة في قطر الزهرة تدريجيا بزيادة مدة بقاء الزهرة٠

وعلى العكس زاد نشاط إنزيم البيروكسيديز فى عنق وقواعد سيقان الأزهار في اليوم الثاني عشر مقارنة باليوم السادس من عمر الزهرة.

انخفضت قيم كل من السـكريات الذائبـة الكليـة فـي البـتلات والأوراق وكـذلك الأنثوسـيانينات والكاروتينويدات في البتلات والكلوروفيلات الكلية والكاروتينويدات فى الأوراق في اليوم الثاني عشـر مقارنـة بالقيم المسجلة فى اليوم السادس من حياة الزهرة٠

زادت قيم الفينولات الكلية الذائبة في كل من البتلات والأوراق في اليوم الثاني عشـر مقارنـة بـاليوم السادس من عمر الزهرة.

أدت معظم محاليل الحفظ الى زيادة جودة الأزهار وتحسين الصفات الفسيولوجية والمحتويات الكيماويـة مقارنة بالماء القطر (معاملة المقارنة).

ويمكـن التوصـية باسـتخدام محلـول الحفـظ المحتـوى علـى ٢% سـكروز + ٢٠٠ جـزء فـي المليـون ٨ -هيدروكسى كينولين + ٢٥٠ جزء في المليون حامض ستريك + ٢ مللى مولر ٢-ميركابتوإيثـانول، حيث أدى إستخدام هذا المحلـول للحصـول علـى أفضـل النتـائج مـن حيث جـودة الأزهـار وتحسـين الصـفات الفسـيولوجية والمحتويـات الكيماويـة، بينمـا أدى استخدام محلول الحفظ المكون من ٢% سكروز + ٢٠٠ جزء في المليون ٨ - هيدروكسى كينولين + ١٠٠ جزء في المليون كبريتـات نحـاس للحصـول علـى أقل جودة للأزهـار وصـفات فسيولوجية ومحتويات كيميائية غير مقبولة.