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POSTHARVEST STUDIES ON CUT ROSE FLOWERS (*Rosa hybrida*, L. cv. First Red). 2-EFFECT OF SOME PRESERVATIVE SOLUTIONS ON FLOWER QUALITY, PHYSIOLOGICAL CHARACATERISTICS AND CHEMICAL COMPOSITIONS OF STORED CUT FLOWERS

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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 longevity, physiological characteristics and chemical composition of rose flowers (Rosa hybrida, L. cv. First Red) stored for 14 days at 2° C. Rose flowers were pulsed in a solution containing kinetin at a concentration of 25 ppm + 8-Hydroxyquinoline at 150 ppm for 24 hours before storing for 14 days at 2° C and a relative humidity (RH) of 85-90%. After that, 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 rate of increase in the flower diameter was decreased steadily with time, also fresh weight of flowers and the rate of daily absorption of the preservative solution were decreased after the 3rd day of holding the flowers in the preservative solutions, while the respiration rate was decreased after the 6th day. On the contrary peroxidase activity in the necks of flowers and stem bases were higher on the 12th day than on the 6th day. The total soluble sugars in the petals and leaves, the anthocyanins and carotenoids in the petals, as well as the total chlorophylls and carotenoids in the leaves, were lower on the 12th day than on the 6th day of holding the flowers in the preservative solutions, whereas the total soluble phenols content in the petals and leaves were higher on the 12th day than on the 6th day.

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% Suc + 200 ppm 8-HQ +2 mM 2-mercaptoethanol + 250 ppm CA can be recommended for holding Rosa hybrida cv. First Red flowers after storage for 14 days on 2° C, as it gave the best results in terms of flower quality, physiological characteristics and chemical compositions, whereas using the preservative solution containing 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ resulted in the lowest quality, as well as unacceptable physiological characteristics and chemical compositions.

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, roses are marked either as potted plants or cut flowers (Figueroa *et al*., 2005). The vase life of cut rose flowers is often short due to wilting and bending of the floral axis just below the flower head (De Stigter, 1980). The development of these symptoms is considered to be caused by vascular occlusion which inhibits water supply to the flowers. The development of this occlusion is correlated with the growth of bacteria at the cut surface and inside the stem (Van Doorn, 1997). Also, flower senescence very often depends on ethylene. A rise in ethylene production that accelerates senescence has been found in cut carnations and roses (Quesada and Valpuesta, 2000). Another important factor in the deterioration of cut flowers involves the diminishing of respiration substrates, which depends, at least in part, on the amount of reserves that are present in the flowers when they are cut (Rogers, 1973). The use of preservative solutions is considered a common practice for maintaining floral stems by controlling ethylene synthesis and pathogen development, as well as the maintenance of a respiration balance, which contributes to color conservation, floral buttons induction, and later to the completion of their development (Arboleda, 1993). For these reasons, many floral preservative solutions contain germicides, ethylene synthesis inhibitors, growth regulators, some mineral compounds, and carbohydrates that are essential to extend the vase life of cut flowers (Halevy and Mayak, 1981). In this respect, many substances used in preservative solutions, such as aluminum sulphate, silver nitrate, silver thiosulphate and sodium thiosulphate, act as bactericides. Silver thiosulphate competes with ethylene for the same site of action (Arboleda, 1993), and therefore reduces the negative effect of ethylene. Also, 8-hydroxyquinoline (usually used at concentrations of 200 to 600 mg /L) is among the chemical compounds most commonly used as floral preservative in roses (Van Doorn, 1997).

The purpose of this study was to evaluate the physiological effects of different compounds used to formulate preservative solutions for floral stems conservation and their influence on the postharvest quality of *Rosa hybrida* cv. First Red flowers, previously stored for 14 days at 2^{o} C.

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 composition of rose flowers (*Rosa hybrida*, L. cv. First Red), which had been stored for 14 days at 2° C.

Rose flowers (*Rosa hybrida,* L. cv. First Red) were obtained from Floramix, a commercial Farm, Kafr Hakim, Giza. On 1st March 2005 and 2006, in both seasons, 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 the 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 within one hour, where they were un-wrapped. The stem bases were then re-cut in air by removing about 3 cm. The flowers were pulsed for 24 hours in a solution containing kinetin at a concentration of 25 ppm + 8-hydroxyquinoline at 150 ppm, then they were bunched (3 flowers /bunch), wrapped in cellophane sheets, packed in a cardboard box (20 X 40 X 100 cm) and stored for 14 days at 2º C and a relative humidity (RH) of 85-90%, as recommended by Badawy *et al.* (2007).

At the end of the cold storage period, the box was moved to a higher temperature (8-10º C) where it was kept for 3 hours, to avoid temperature stress to the flowers, which may be caused by sudden exposure to the normal atmosphere. After that, the flowers were taken out of the box, and 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. The jars were kept in the laboratory at 25 ± 2 ºC. Data were recorded on flowers held in the different preservative solutions, including:

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 Lurie and Pesis (1992).

- Peroxidase activity was determined twice in the neck and stem base, on the 6th and 12th day from the beginning of the holding periods, using the method described by Amako *et al.* (1994).

III – Chemical compositon:

On the 6th and 12th days of the holding period, chemical analysis was conducted to determine the contents of total soluble sugars in the fresh petals and leaves (according to Dubois *et al*., 1956), total soluble phenols in the fresh petals and leaves (according to the A.O.A.C., 1980), anthocyanins in the fresh petals (according to Fuleki and Francis, 1968), total chlorophylls (a + b) in fresh leaves, and carotenoids in fresh leaves and petals (according to 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 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 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 tested preservative solutions significantly increased the longevity of flowers as compared to flowers placed in distilled water (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 insignificantly decreased flower longevity in both seasons, as compared to flowers placed in distilled water. 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, the flowers placed in 2% sucrose + 200 ppm 8-HQ +2 mM 2-mercaptoethanol + 250 ppm citric acid (CA) gave significantly higher values for longevity (14.00 and 13.67 days in the first and second seasons, respectively) as compared with most of the other treatments. This result is in agreement with the findings of Van Doorn and Vaslier (2002), who reported that treatment of *Dendranthema grandiflora* cv. Vyking flowers with 2 mM 2-mercaptoethanol delayed wilting. There was no significant difference between the highest longevity recorded, and that of flowers placed in 2% Suc + 200 ppm 8-HQ + 1 mM boric acid and this result may be due the effect of boric acid which prevents the early rise in ethylene production and considerably improves vase life, as reported by Serrano *et al.* (2001) on *Dianthus caryophyllus* cv. Master.

Table 1: Effect of preservative solutions on the longevity (days) of rose flowers (*Rosa hybrida* cv. First Red) stored at 2° C for 14 days during the 2005 and 2006 seasons.

Preservative solutions		Longevity (days)	
		(2005)	(2006)
Distilled water		6.00	6.00
2% Suc + 200 ppm 8-HQ + 250 ppm CA	————	11.67	12.00
	+ 2 mM 2-mercaptoethanol	14.00	13.67
	+ 0.1% $Ca(NO_3)_2$	12.00	12.67
2% Suc + 200 ppm 8-HQ	————	9.00	9.33
	+ 100 ppm $CuSO_4$	5.67	5.67
	+ 1 mM boric acid	12.67	13.00
L.S.D at (5%)		1.40	0.95

2-The rate of flower weight changes

Data presented in Table 2 revealed that, in both seasons, the flower weight within each preservative solution was higher after 3 days in the holding solution, compared to the initial flower weight, in most cases. These results are in agreement with those recorded 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. On the other hand, data recorded on the 6th, 9th and 12th days revealed a steady reduction in flower weight. A similar conclusion was found by Faragher (1986) on *Telopea speciosissima*, who reported that increasing vase life was accompanied by a slow rate of decrease in flower and bract fresh weight. Also, it is noted that all the treatments which caused an increase in flower weight during the first six days of the holding period contained an acid (either citric acid or boric acid), which may indicate a favourable effect of acidity on flower weight, possibly due an increase of water uptake, or a reduction of bacterial growth which may cause occlusion of the vascular tissues. 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. These results are in agreement with the conclusion reached by 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 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/day) of rose flowers (*Rosa hybrida* cv. First Red) stored at 2° C for 14 days during the 2005 and 2006 seasons.

Preservative solutions		Holding periods (H), day							
		(2005)				(2006)			
		3	6	9	12	3	6	9	12
		Rate of flower weight changes							
Distilled water		-0.40	-0.67	—	—	-0.65	-0.93	—	——
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	+0.48	+0.23	-0.37	-0.44	+0.75	+0.51	-0.68	-0.81
	+ 2 mM 2-mercaptoethanol	+0.72	+0.60	-0.08	-0.14	+1.27	+1.12	-0.21	-0.48
	+ 0.1 % $Ca(NO_3)_2$	+0.52	+0.28	-0.23	-0.36	+0.96	+0.49	-0.47	-0.63
2% Suc + 200 ppm 8-HQ	———	-0.32	-0.46	-0.60	—	-0.31	-0.46	-0.60	——
	+ 100 ppm $CuSO_4$	-0.64	-0.79	–	—	-0.78	-1.01	—	—
	+ 1 mM boric acid	+0.62	+0.46	-0.17	-0.26	+1.16	+0.95	-0.35	-0.55
		Rate of increase in the flower diameter							
Distilled water		0.11	0.05	–	–	0.06	0.04	–	—
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	0.34	0.31	0.22	0.25	0.33	0.28	0.26	0.20
	+ 2 mM 2-mercaptoethanol	0.66	0.66	0.44	0.38	0.60	0.39	0.42	0.38
	+ 0.1 % $Ca(NO_3)_2$	0.44	0.39	0.33	0.27	0.35	0.33	0.27	0.25
2% Suc + 200 ppm 8-HQ	———	0.36	0.27	0.15	--	0.26	0.21	0.17	—
	+ 100 ppm $CuSO_4$	0.17	0.14	—	-	0.18	0.09	–	—
	+ 1 mM boric acid	0.58	0.47	0.40	0.38	0.47	0.36	0.37	0.27
LSD (5%) P x H		N.S				N.S			

The 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, and the lowest rate of flower weight loss on the 9th and 12th days of the holding period, as compared to the values recorded with flowers placed in the other preservative solutions. On the other hand, the highest rates of flower weight loss on the 3rd and 6th days of the holding period were recorded with flowers placed in a solution containing 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$, which wilted after that.

3-The rate of increase in flower diameter

In both seasons, the rate of increase in flower diameter was not significantly affected by the interaction between the effects of the preservative solutions and the

holding periods (Table 2). In all preservative solutions, the rate of increase in the flower diameter decreased steadily with prolonging holding periods (in most cases).

In both seasons, on the 3rd and 6th day of the holding period the rate of increase in the flower diameter was higher in the flowers placed in the different preservative solutions, as compared to values recorded with flowers placed in distilled water. A similar result was reported by Michalczuk *et al*. (1989) on rose cvs. Sonia, Celica, Samantha, and Mercedes, who reported that calcium applied to cut rose flowers mainly as $Ca(NO_3)_2$ at the concentration of 0.25% to preservative solution containing 2% sucrose + 200 ppm 8-HQ promoted the increase in flower diameter as compared with using 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. In 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 the flower diameter. On the 3rd and 6th days, the lowest rate of increase in the flower diameter was recorded with flowers placed in distilled water (before wilting). This result is in agreement with the conclusion reached by Bhattacharjee (1994) on *Rosa hybrida*, who reported that distilled water gave the lowest increase in the flower diameter compared with different preservative solutions.

II- Physiological characteristics

1-The rate of daily absorption

In both seasons, the rate of daily absorption was significantly affected by the interaction between the effects of the vase solutions and holding periods (Table 3). Within each preservative solution, the rate of daily absorption was significantly decreased with prolonging the holding periods, in most cases. Similar decreases in the rate of daily absorption have been reported by Pascale and Viggiani (1998) on *Godetia grandiflora* cvs. Grace Red and Grace Rose, and Hettiarachchi and Balas (2003) on *Codiaeum variegatum*, who concluded that increasing vase life was accompanied with a decrease in water uptake. Also, Bhattacharjee and Pal (1999) found that water uptake of *Rosa hybrida* increased till the fourth day in the vase and declined at senescence, while Chungwei *et al*. (2002) reported that water absorption of cut roses cv. Grand Gala increased till the third day and then decreased slightly till senescence.

Data recorded on the 3rd and 6th days of the holding period showed that most of the preservative solutions significantly increased the rate of daily absorption, compared to that of flowers placed in distilled water. This increase in the rate of daily absorption was more pronounced in the flowers held in preservative solutions containing an acid (boric or citric acid). In both seasons, within each holding period, placing rose flowers in a solution containing 2% sucrose + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA resulted in a significantly higher daily absorption rate, as compared to the values recorded with flowers placed in any other preservative solutions (in most cases). The favourable effect of 2-mercaptoethanol on absorption was explained by Van Doorn and Cruz (2000) who reported that 2- mercaptoethanol

prevented net water loss by cut chrysanthemum flowers, prevented bacterial growth in the stem ends, and gave a high number of cavitated xylem conduits because of reducing the pH to below 5. Hence, the blockage was inhibited by low pH. On the other hand, flowers treated with 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ had the lowest absorption rate on the 3rd and 6th days (before wilting). This result is in agreement with the findings of Kim *et al.* (1996) on *Ustilago maydis*, who reported that the rate of water uptake was lower in the flowers treated with copper sulfate.

2-Respiration Rate

In both seasons, the respiration rate was significantly affected by the interaction between the preservative solutions and holding periods (Table 3). On the 6th day of holding period, in all preservative solutions, the respiration rate was significantly higher, 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), who found that respiration rate of tulip and *Alstroemeria* petals decreased during senescence, and Bhattacharjee and Pal (1999), who reported that the respiration rate of rose flowers increased sharply during the 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 period the respiration rate was increased in flowers placed in different preservative solutions, as compared to the values recorded with flowers placed in distilled water. In most cases, 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 as compared to values recorded with the other solutions. It is worth mentioning that this solution extended vase life of cut rose flowers from 6 days (in distilled water) to 14 and 13.67 days in the first and second seasons, respectively (Table 1). This result is in agreement with Pal *et al*. (2003) on cut roses cv. First Red, they reported that addition of sucrose and HQC in the holding solution further helped in maintaining the overall quality characteristics of cut flower, such as respiration rate. The lowest respiration rate was obtained with flowers placed in distilled water. These results are in agreement with the findings of Pascale and Viggiani (1998) on *Godetia grandiflora*, who reported that the respiration rate decreased during senescence of cut flowers and was increased by keeping them in the preservative solution, and Viggiani and Pascale (1998) on *Rosa hybrida* cvs. Dallas and Maya, who reported that the preservative solution increased respiration rate by providing an additional source of carbon.

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) stored at 2° C for 14 days during the 2005 and 2006 seasons.

Preservative solutions		Holding periods (H), days							
		(2005)				(2006)			
		3	6	9	12	3	6	9	12
		Rate of daily absorption (g/flower/day)							
Distilled water		9.37	5.09	———	———	10.60	6.26	———	———
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	11.01	10.51	8.81	4.72	11.43	10.14	9.07	6.14
	+ 2 mM 2-mercaptoethanol	15.32	13.92	11.61	6.11	16.81	15.03	13.01	9.79
	+ 0.1 % $Ca(NO_3)_2$	12.04	11.16	9.08	5.03	13.90	11.23	9.87	6.90
2% Suc + 200 ppm 8-HQ	———	10.63	8.92	7.01	———	11.04	9.71	8.23	———
	+ 100 ppm $CuSO_4$	8.63	4.43	———	———	8.66	3.36	———	———
	+ 1 mM boric acid	13.80	11.49	9.60	5.90	14.85	12.03	10.76	8.11
LSD (5%) P x H		1.35				1.10			
		Respiration rate (ml CO_2/g/hr)							
Distilled water		53.04	70.56	———	———	49.42	68.74	———	———
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	58.90	91.09	64.52	34.61	52.29	89.83	60.74	31.45
	+ 2 mM 2-mercaptoethanol	68.94	98.53	77.80	41.21	60.63	105.74	69.28	43.52
	+ 0.1 % $Ca(NO_3)_2$	60.32	92.69	66.51	36.73	54.70	98.14	60.41	34.55
2% Suc + 200 ppm 8-HQ	———	55.72	86.43	59.65	–	51.80	81.21	56.36	–
	+ 100 ppm $CuSO_4$	54.81	76.38	–	–	51.42	72.90	–	–
	+ 1 mM boric acid	65.47	95.93	70.58	38.26	58.90	100.36	67.28	37.44
LSD (5%) P x H		3.06				5.38			

3- Peroxidase activity in the neck and stem base of the rose flowers

Data presented in Table 4 showed that, in both seasons, the peroxidase (POD) activity in the neck and stem of the flowers was significantly affected by the interaction between preservative solutions and holding periods. Within each preservative solution, peroxidase activity in the neck and stems of the surviving flowers was higher on the 12th day of the holding periods than on the 6th day. The increase in peroxidase activity in the neck and stem of rose flowers as a result of prolonging holding period was more pronounced in the second season, and gave significant differences between the values obtained from the surviving flowers on the 12th day and the values recorded on the 6th day (within each preservative solution). These results are in agreement with conclusions reached by Xue and Lin (1999) on

rose flowers, and Liao *et al.* (2003) on gerbera flowers, who reported that peroxidase activity increased rapidly during vase holding

On the 6th day, it was evident that rose flowers placed in most of the preservative solutions had lower peroxidase activity in the neck, compared to flowers placed in distilled water (the decrease in peroxidase activity was significant in most cases). On the other hand, on the 6th and 12th days of the holding periods, flowers placed in 2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA showed higher peroxidase activity in the flower necks, as compared to the control or to the flowers held in the other preservative solutions, and this increase in peroxidase activity was associated with the highest longevity (as mentioned in Table 1).

Table 4: Effect of preservative solutions and holding periods on the peroxidase activity (units/mg protein) in the neck and stem base of rose flowers (*Rosa hybrida* cv. First Red) stored at 2° C for 14 days 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
		In the neck				In the stem base			
Distilled water		19.80	———	21.27	———	14.27	———	16.84	———
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	16.21	18.86	15.67	20.73	9.97	11.18	13.67	16.85
	+ 2 mM 2-mercaptoethanol	20.37	23.12	27.43	30.55	6.60	8.51	8.76	10.43
	+ 0.1 % $Ca(NO_3)_2$	18.11	19.22	19.65	22.42	8.40	9.15	12.23	14.66
2% Suc + 200 ppm 8-HQ	———	14.52	———	14.02	———	13.03	———	20.09	———
	+ 100 ppm $CuSO_4$	8.50	———	16.54	———	11.97	———	15.98	———
	+ 1 mM boric acid	18.25	19.64	19.85	22.80	7.13	8.80	11.20	13.85
LSD (5%) P x H		1.90		2.03		1.19		1.33	

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). These results are in agreement with the findings of Kim and Lee (2002), they reported that the preservative solutions which increased longevity of rose flowers resulted in higher peroxidase activity in the flower necks.

On the 6th day, it was evident that, in most cases, rose flowers placed in the different preservative solutions had lower peroxidase activity in the stem base, compared to the flowers placed in distilled water. In many cases, the decrease in peroxidase activity in the stem base as a result of using preservative solutions was significant. On the 6th and 12th days of the holding periods, rose 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, as compared to the flowers placed in the other preservative solutions. This result can be attributed to the role of 2-mercaptoethanol as an inhibitor of peroxidase activity and, consequently, preventing the development of a physiological blockage, mainly 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 in increasing the longevity of rose flowers is presented in Table 1.

Data presented in Table 4 revealed that 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 flower.

III-Chemical composition

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 the values recorded on the 6th day (in most cases). These results are 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 petals and leaves of flowers was significantly higher in flowers placed in most of the preservative solutions tested, as compared to 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). A few exceptions to this trend were recorded with flowers placed in the solution containing 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$, which gave an insignificantly lower total soluble sugars content in petals on the 6th day in the first season, whereas flowers placed in 2% Suc + 200 ppm 8-HQ gave an insignificantly higher value in the second season, as compared to the values recorded with flowers placed in distilled water. Also, flowers placed in the solution containing 2% Suc + 200 ppm 8-HQ gave an insignificantly higher total soluble sugars content in leaves on the 6th day in both seasons, as compared to the control (the flowers placed in distilled water).

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 petals and leaves, as compared to most of the other treatments. Also, this treatment proved to be the best treatment, by giving higher total soluble sugars contents in the petals and leaves on the 12th day, compared to the other values recorded on this day for the surviving flowers. These results indicated that extended vase life was associated with increasing the total soluble sugars contents in the petals and leaves (Tables 1 and 5). These results are in agreement with the findings of 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 be an indication that vase life and carbohydrate supply are closely correlated. Supplementing flowers with materials needed for carbohydrate metabolism is essential for extending vase life, flower growth and development.

Table 5: Effect of preservative solutions and holding periods on the total soluble sugars (g/100 g F.W.) and total soluble phenols (mg/g F.W.) contents in the petals and leaves of rose flowers (*Rosa hybrida* cv. First Red) stored at 2° C for 14 days during the 2005 and 2006 seasons.

Preservative solutions (P)		Holding periods (H), day							
		Petals				Leaves			
		(2005)		(2006)		(2005)		(2006)	
		6	12	6	12	6	12	6	12
		total soluble sugars							
Distilled water		1.17	——	1.89	——	0.45	——	1.18	——
2% Suc + 200 ppm 8-HQ + 250 ppm CA	——	1.72	1.24	3.32	1.39	0.84	0.67	1.68	1.27
	+ 2 mM 2-mercaptoethanol	2.32	1.86	4.47	3.92	1.68	1.29	2.89	2.03
	+ 0.1 % $Ca(NO_3)_2$	1.80	1.46	3.86	1.54	1.00	0.86	1.98	1.45
2% Suc + 200 ppm 8-HQ	——	1.61	——	2.09	——	0.50	——	1.25	——
	+ 100 ppm $CuSO_4$	1.01	——	1.44	——	1.14	——	2.00	——
	+ 1 mM boric acid	2.06	1.56	4.26	1.51	1.29	0.94	2.23	1.78
LSD (5%) P x H		0.28		0.36		0.18		0.22	
		total soluble phenols							
Distilled water		7.07	–	11.10	–	6.14	—	8.49	——
2% Suc + 200 ppm 8-HQ + 250 ppm CA	——	5.07	6.15	7.32	9.17	4.61	5.19	6.89	7.09
	+ 2 mM 2-mercaptoethanol	7.46	8.47	10.24	13.56	6.43	8.70	11.20	15.28
	+ 0.1 % $Ca(NO_3)_2$	5.64	7.08	9.72	10.12	4.74	5.62	7.53	9.61
2% Suc + 200 ppm 8-HQ	——	6.65	——	9.49	——	4.43	——	4.34	—
	+ 100 ppm $CuSO_4$	8.60	——	13.90	——	9.17	——	15.00	—
	+ 1 mM boric acid	6.98	7.46	10.00	12.84	6.34	7.61	8.66	10.83
LSD (5%) P x H		0.44		0.64		0.36		0.75	

Generally, the presence of $CuSO_4$ in the vase solution was unfavorable, as it resulted in the lowest total soluble sugars content in petals on the 6th day (1.01 and 1.44 g/100 g fresh weight in the first and second seasons, respectively), before wilting. Also, flowers placed in distilled water gave lower total soluble sugars content in the petals in the 6th day before wilting, as compared with most of other treatments, and gave the lowest total soluble sugars content in the leaves compared to all the other

treatments. These results are in agreement with conclusions reached by Kaltaler and Steponkus (1976) who noted that petal sugars decreased slightly in roses maintained in distilled water.

In general, the petals contained higher total soluble sugars content than leaves. This observation 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, the flowers surviving till the 12th day of vase life had significantly higher total soluble phenols contents in petals and leaves of rose flowers as compared to the values recorded on the 6th day of vase life, in most cases. These results are in agreement with the findings of Mwangi *et al*. (2003) on cut rose cv. Golden Gate, they reported that total soluble phenols were increased during flower development and senescence.

On the 6th day of the vase life, the flowers placed in 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ had significantly higher total soluble phenols contents in the petals and leaves, compared to the flowers held in any other preservative solution, 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 had significantly higher total soluble phenols contents in the petals and leaves, compared to the surviving flowers placed in the other solutions.

In general, rose petals had a higher content 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, in most cases, the anthocyanins and carotenoids contents were significantly affected by the interaction between effects of preservative solutions and holding periods. On the 12th day of the holding period, within each preservative solution, the surviving flowers gave insignificantly lower anthocyanins (in most cases) and significantly lower carotenoids content in the petals of rose flowers, as compared to the values recorded in the 6th day. These results are in agreement with that obtained by Solecka and Goaszewska (1985) on cut rose flowers, they found that anthocyanins content decreased with senescence, and Faragher (1986) on *Telopea speciosissima*, who found that during vase life, anthocyanins content of flowers decreased. Also, Ferrante *et al*. (2004) on cut stock flowers found that total carotenoids drastically decreased at the end of vase life.

On the 6th day, it was evident that placing the flowers in a preservative solution containing 2% Suc + 200 ppm 8-HQ + 100 ppm $CuSO_4$ gave lower

anthocyanins and carotenoids contents than those found in the control flowers. On the other hand, placing the flowers in most of the other solution resulted in significant increases in anthocyanins and carotenoids contents in the petals on the 6th day, as compared to the values recorded with flowers placed in distilled water. Similar increases in the anthocyanins content were obtained by Lukaszewska (1980), who reported that cut carnation flowers placed in a preservative solution had higher anthocyanins content than the control flowers. In most cases, the flowers placed in the solution containing 2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA gave the highest anthocyanins and carotenoids content in the petals on the 6th day, as compared to the flowers placed in the other preservative solutions. Also, this treatment (2% Suc + 200 ppm 8-HQ + 2 mM 2-mercaptoethanol + 250 ppm CA) gave the highest values in the flowers that survived till the 12th day.

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

Data presented in Table 6 showed that, in both seasons, the total chlorophylls (a+b) and carotenoids contents were significantly affected by the interaction between preservative solutions and holding periods. Within each of the preservative solution, rose flowers surviving till the 12th day of the holding period 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). Similar results were obtained by Skutnik *et al*. (2001) on *Zantedeschia aethiopica*, they reported that after harvest, chlorophyll content of the leaves fell more or less rapidly depending on the postharvest treatment.

On the 6th day of the holding period, in most cases, the total chlorophylls (a+b) and carotenoids contents in the leaves of rose flowers placed in preservative solutions were significantly higher than those of flowers placed in distilled water. This result is in agreement with the findings of Behera (1993) on carnation cv. White Sim, who reported that the rate of chlorophyll degradation in the leaves with time was significantly lower in sucrose-treated flowers than in water-treated flowers.

The leaves of 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, compared to flowers placed in the other preservative solutions. Also, the flowers receiving this treatment gave higher values on the 12th day than those obtained from most of the surviving flowers placed in the other preservative solutions.

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 rose flowers (*Rosa hybrida* cv. First Red) stored at 2° C for 14 days during the 2005 and 2006 seasons.

Preservative solutions (P)		Holding periods (H),							
		(2005)		(2006)		(2005)		(2006)	
		6	12	6	12	6	12	6	12
		Anthocyanins contents in petals				Carotenoids contents in petals			
Distilled water		0.19	---	0.38	---	20.38	———	18.46	———
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	0.43	0.18	0.49	0.42	31.22	24.86	37.46	20.01
	+ 2 mM 2-mercaptoethanol	0.44	0.31	0.72	0.69	53.76	27.65	72.95	46.23
	+ 0.1 % $Ca(NO_3)_2$	0.28	0.20	0.68	0.56	40.04	25.23	48.46	31.62
2% Suc + 200 ppm 8-HQ	———	0.25	---	0.63	---	27.37	———	26.82	———
	+ 100 ppm $CuSO_4$	0.13	---	0.22	---	16.26	———	17.67	———
	+ 1 mM boric acid	0.39	0.24	0.70	0.63	54.35	28.50	67.33	40.00
LSD (5%) P x H		NS		0.08		3.24		3.42	
		Total chlorophylls (a+b) content in leaves				carotenoids content in leaves			
Distilled water		30.12	———	20.37	———	18.20	———	10.30	———
2% Suc + 200 ppm 8-HQ + 250 ppm CA	———	36.17	30.54	35.21	29.73	17.40	15.00	19.97	15.81
	+ 2 mM 2-mercaptoethano	46.31	42.22	70.18	62.19	27.40	20.80	36.44	27.32
	+ 0.1 % $Ca(NO_3)_2$	39.84	32.57	53.29	41.91	21.40	17.80	21.44	18.72
2% Suc + 200 ppm 8-HQ	———	34.73	———	29.54	———	20.40	———	17.42	———
	+ 100 ppm $CuSO_4$	22.53	———	15.89	———	13.20	———	8.31	———
	+ 1 mM boric acid	40.89	37.99	54.37	41.75	23.40	19.40	29.27	22.65
LSD (5%) P x H		4.90		3.80		2.20		2.51	

Recommendation: From the above mentioned results it can be recommended that *Rosa hybrida*, L. cv. First Red flowers stored for 14 days on 2°C should 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 constituents 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.* Pp. 832-849. Washington. D.C.USA.

Arboleda P.J.A. (1993). *Principios fundamentales de la postcosecha de flores.* En: Tercer Seminario Técnico de Floricultura/EXPOFLOR 93, 11-14 de junio. Pp.

44. Huixquilucan, Estado de México, México.

Badawy, E.M.; M.M.M. Hussein and N. T. Shanan (2007). Postharvest studies on cut rose flowers (*Rosa hybrida*, L. cv. First Red). 1- Effect of some pulsing solutions and cold storage periods on the physiological characteristics and chemical constituents of *Rosa hybrida*, L. cv. First Red flowers. *J. Product. & Dev.*, **12**(1):61-83.

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 varietals 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.

Halevy, A.H. and S. Mayak (1981). Senescence and postharvest physiology of cut flowers, Part 2. *Hortic. Rev.* , **3:**59-143.

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.

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 Horticulturae Sinica,* **30**(1): 110-112.

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

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 treatments 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.

Quesada, M.A. and V. Valpuesta (2000). Juvenilidad, senescencia y abscisión. pp.451-464. In: J. Azcón-Bieto y M.Talón (eds.) Fundamentos de FisiologíaVegetal. McGraw Hill. Madrid, España.

Rogers, M.N. (1973). An historical and critical review of postharvest physiology research on cut flowers. *HortScience*, **8**(2):189-194.

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

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 Kwiaciarstwa Skierniewicach, B. (Rosliny Ozdobne), **10**: 53-58.

Van Doorn, W. G. (1997). Water relations of cut flowers. *Hort. Rev.,* **18**: 1–18.

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) ٢- تأثير بعض محاليل الحفظ على جودة الزهرة والصفات الفسيولوجية والمحتويات الكيماوية للأزهار المخزنة٠

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) التي سبق تخزينها لمدة ١٤ يوم على درجة حرارة ٢° م.

حيث تم غمس قواعد سيقان الأزهار في محلول يحتوى علي الكينتين بتركيز ٢٥ جزء في المليون + ٨ - هيدروكسى كينولين بتركيز ١٥٠ جزء في المليون لمدة ٢٤ ساعة، ثم خزنت الأزهار على درجة ٢° م ورطوبة جوية ٨٥-٩٠% لمدة ١٤ يوم. بعد ذلك 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 حامض ستريك٠
٣. "" + "" + "" + ٢ مللى مولر ٢- ميركابتو إيثانول.
٤. "" + "" + "" + ٠.١% نترات كالسيوم.
٥. ٢% سكروز + ٢٠٠ جزء في المليون ٨ - هيدروكسى كينولين.
٦. "" + "" + ١٠٠ جزء في المليون كبريتات نحاس.
٧. "" + "" + ١ مللى مولر حمض بوريك.

أظهرت النتائج ما يلي:

انخفاض معدل الزيادة في قطر الزهرة بزيادة مدة بقاء الزهرة وكذلك إنخفاض الوزن الطازج ومعدل الإمتصاص اليومي بعد اليوم الثالث بينما انخفض معدل التنفس بعد اليوم السادس.

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

انخفضت قيم كل من السكريات الذائبة الكلية في البتلات والأوراق وكذلك الأنثوسيانينات والكاروتينويدات في البتلات والكلوروفيلات الكلية والكاروتينويدات في الأوراق في اليوم الثاني عشر مقارنة بالقيم المسجلة في اليوم السادس من حياة الزهرة ٠

زادت قيم الفينولات الكلية الذائبة في كل من البتلات والأوراق في اليوم الثاني عشر مقارنة باليوم السادس من عمر الزهرة.

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

يمكن التوصية بإستخدام المحلول المحتوى على ٢% سكروز + ٢٠٠ جزء في المليون ٨ - هيدروكسى كينولين+ ٢٥٠ جزء في المليون حامض ستريك + ٢ مللى مولر ٢-ميركابتوإيثانول لحفظ أزهار الورد السابق تخزينها لمدة ١٤ يوم على درجة ٢° م، حيث أعطى هذا المحلول أفضل النتائج من حيث جودة الأزهار وتحسين صفاتها الفسيولوجية ومحتوياتها الكيماوية، بينما أدى استخدام محلول الحفظ المكون من ٢% سكروز + ٢٠٠ جزء في المليون ٨ - هيدروكسى كينولين + ١٠٠ جزء في المليون كبريتات نحاس للحصول على أقل جودة للأزهار وصفات فسيولوجية ومحتويات كيميائية غير مقبولة.