Vase Life Extension of Rose Cut Flowers (Rosa Hybrida) as Influenced by Silver Nitrate and Sucrose Pulsing

Mohy Eldeen Nour Eldaim Elgimabi
Faculty of Science, Taif University, Saudi Arabia, P.O.Box.888

Abstract: Problem statement: This experiment was carried out in the laboratory of the Department of the Biology, Taif University, Saudi Arabia. Approach: The study was conducted to investigated the silver nitrate (AgNO₃) and sucrose at different concentration on rose cut flowers longevity, which determined on the basis of wilting, chlorophyll retention and carbohydrate degradation. The treatments were, water control, 20, 30 or 50 ppm AgNO₃ and sucrose at 1,2 or 3% w/v. Results: The results showed, flower vase life was prolonged by all AgNO₃ treatments. The best concentration was 30 ppm. The effect was further improved when AgNO₃ was combined with 3% sucrose, which recorded the best vase life compared to other concentrations of sucrose. The per cent of wilting was minimized as result of using this combined treatment however the per cent of wilting increased with the increase in concentrations of AgNO₃ and complete wilting occurred after 10, 8 and 7 days when treated with 20, 30 and 50 ppm of AgNO₃, respectively, while sucrose shortened the period to reach wilting. Also AgNO₃ at 30 ppm retarded the chlorophyll as well as carbohydrate degradation during the postharvest life. The experiments were repeated three times with three replicates and a completely randomized design had been used. The experiments extended from February, 2006-September, 2008. The difference between means was performed using Duncan multiple range test at 0.05 levels. Conclusion: A significant improvement in vase life of rose cut flowers was occurred when treated with 30 ppm (AgNO₃) more effects when combined with 3% (w/v) sucrose, so we recommended that to use the previous treatments with this concentrations for a long vase life and commercial productions.

Key words: Vase life, rose cut flowers, sucrose pulsing, carbohydrate degradation, randomized design, silver nitrate, bacterial proliferation, Rosa hybrida, chlorophyll determination

INTRODUCTION

Rose, a universally celebrated flower, has been used as a garden plant since the dawn of civilization. Rose is a symbol of perfection, elegance, romance and love. It was called “The Queen of Flowers” firstly by Greek poetess in her “Ode to the Rose” (Muhammad et al., 1996). Roses (Rosa hybrida) belong to family Rosaceae and Genus Rosa which contains more than 150 species and 1400 cultivars (Synge, 1971). Rose enjoys superiority over all other flowers being extensively used for decorative purposes and is prized for its delicate nature, beauty, charm and aroma. Rose is recognized for its high economic value, which are used in agro-based industry especially in cosmetics and perfumes. Additionally, roses play a vital role in the manufacturing of various products of medicinal and nutritional importance. However, the main idea of rose plant cultivation is to get the cut flowers, which greatly deals with the floricultural business (Butt, 2003).

Vase life of cut rose flowers is usually short. Cut flowers wilt and floral axis become bent (bent-neck) just below the flower head (Van Doorn et al., 1997). The development of such symptoms is considered to be caused by vascular occlusion, which inhibits water supply to the flowers (Loub and Van Doorn, 2004).

Several methods to increase the vase life of cut flowers and keep their freshness for longer periods have been reported. Cut flowers should be free of any deterioration, as this is one of the principal entry points for decay organisms (Hardenburg, 1968). A major form of deterioration in cut flowers is the blockage of xylem vessels by air and microorganisms that cause xylem occlusion (Hardenburg, 1968).

Silver nitrate (AgNO₃) is one of the most common forms of silver salts used in commercial flower preservatives solutions and mostly used as ethylene binding inhibitor. Pulsing with (AgNO₃) strikingly enhanced vase life and solution uptake in rose cut flowers (Singh and Tiwari, 2002). Also Darras et al. (2010) reported that, pulsing with 20 or 40 mg L⁻¹ AgNO₃ for 24h extended vase life by 1.6 and 1.9 days, respectively, compared to the control.

Furthermore, treatment with germicides, such as silver nitrate (Ohkawa et al., 1999) or 8-hydroxyquinoline sulfate (Gilman and Steponkus, 1972; Ichimura, 2003), inhibited bacterial proliferation and maintained the hydraulic conductance of stem. These
findings suggest that bacterial proliferation is responsible for vascular occlusion, which shortens the vase life of cut rose flowers. Pulsing of cut roses for 10-20 mint with AgNO₃ improved the vase life up to 6.0 and 5.3 days, respectively (Reddy et al., 1988).

On other hand, sucrose pulsing increased the vase life of different cut flowers. Different concentrations of sucrose had been investigated by Butt (2005) on two cultivars of Rasa hybirida and results showed that sucrose at 25 g mL⁻¹ extended the vase life by 8.2 days in var. Whisk Mc and 7.5 days in var. Trika as compared to 5.3 days in control (Butt, 2005). Also Pun et al. (2005) treated cut spry carnation by different concentrations of sucrose ranging from 0-7.5% and found that 5.0% sucrose recorded the best vase life and delayed the climacteric ethylene in petals. The vase life was more extended when added sucrose to the AgNO₃. Furthermore, Cho and Lee (1980) study the effect of combination between these two chemical on cut rose cv, Mary Devor and result in the vase life was doubled when treated with 3% sucrose+50 ppm AgNO₃ compared to control. Also, pulsing with AgNO₃ and sucrose + citric acid solution for 16 h was extended the vase life of rose cut flowers due to preventing the bent-neck of flower stem (Halevy et al., 1978). Also addition of bactericides and fungicides in solution of AgNO₃ and sucrose improved the flower size and largest buds opened in three days instead of five days; whereas, their vase life was four days greater than control (Nikolova and Koneazak, 1986).

MATERIALS AND METHODS

Site: The experiment site was University of Taif, laboratory of the Department of Biology, Saudi Arabia.

Plant materials: Cut flowers of roses were obtained from a commercial grower in Taif, Saudi Arabia. Flower stems were trimmed to 30 cm underwater to avoid air embolisms (Van Leperen et al., 2001). All leaves on the lower section of the stem were removed.

Treatment setting: Treatments were set following completely randomized design. Each treatment replicated by 3 replication.

Experiment (1): Silver nitrate (AgNO₃) was applied at concentrations of 0, 20, 30 or 50 ppm .Sucrose was used at concentrations of 0, 1, 2 or 3% w/v. The two compounds were dissolved in sterilized distilled water in 250 mL bottle glass (Miyamoto et al., 1999). The sample had been divided into seven groups with three replications containing three flowers each. The flowers were kept at room temperature (23±1°C) at normal day light and natural ventilation. Visual rating of flowers was carried out on the basis of a scale from 1-4 according to Hassan (2005) where: 1= entirely fresh flowers and 4= wilting in 50-100% of the petals.

Experiment (2): AgNO₃ at 30 ppm and sucrose at concentration 3% (w/v) gave the best results in experiment (1). Hence, the effect of both concentrations of AgNO₃ and sucrose on chlorophyll retention and carbohydrate degradation was further investigated.

Chlorophyll determination: Chlorophyll was extracted by methanol and absorbance was determined by a spectrophotometer on day 1, 3 and 5, according to the method of Harborne (Nowak and Rudnicki, 1990). Chl a and Chl b were then calculated using the flowing equation:

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\text{Chl a (mg l}^{-1}) = 12.21 \ A_{663} - 2.81 \ A_{646}; \ \text{Chl b (mg l}^{-1}) = 20.13 A_{646} - 5.03 A_{663}.
\]

Carbohydrates determination: Carbohydrates were determined on the stems and petals of the best treatment of the two compounds. Samples were taken on day 1, 3 and 5 and separated by a High Performance Liquid Chromatography (HPLC) fitted with differential refractometer to detect fructose, glucose and sucrose in the different samples (Hassan, 2005).

RESULTS

Effect of AgNO₃ and sucrose on vase life of rose cut flowers: The vase life of cut rose flowers was extended by the different concentrations of AgNO₃ used in Table 1 and Fig. 1. The vase life was longer in AgNO₃ at 30 ppm which resulted in 8.97 days compared to other concentrations (Table 1). Sucrose resulted in the lowest vase life compared to AgNO₃ at the different concentrations used. The longest vase life was attained when sucrose was applied at 3% w/v, which gave 6 days in comparison to 5 days for control. However, the two compounds used significantly extended the vase life of rose cut flowers compared to control.

Table 2 showed that the per cent wilting increased with the increase in concentrations of AgNO₃. The vase life was terminated on day 11, 10 and 9, when cut flowers were treated with 20, 30 or 50 ppm 8-HQS, respectively compared to 6 days in control. Sucrose resulted in the lowest period to reach wilting per cent. Thus, wilting occurred on the 8th day after treatment with sucrose at different concentrations compared to 6 days in control (Table 2).
Table 1: Effect of AgNO₃ and sucrose on vase life of rose cut flowers (Rosa hybrida)

| Treatment          | Vase life (days) |
|--------------------|------------------|
| AgNO₃ 20 ppm       | 9.30b            |
| AgNO₃ 30 ppm       | 10.97a           |
| AgNO₃ 50 ppm       | 7.97c            |
| Sucrose 1%         | 5.77ef           |
| Sucrose 2%         | 5.97e            |
| Sucrose 3%         | 7.07cd           |
| Control            | 4 f              |

*: Different letters indicate the significant differences between means, according to Duncan multiple range p = 0.05.

Table 2: Calculation of per cent wilting in rose cut flowers treated with different concentrations of AgNO₃ and sucrose compared to control

| Days after treatments | AgNO₃ conc. (ppm) | Sucrose conc. % (w/v) | Control |
|-----------------------|-------------------|-----------------------|---------|
|                       | 20                | 30                    | 50      |
|                       | 1                 | 0.1                   | 2.9     |
|                       | 14.5              | 11.3                  | 15.5    |
|                       | 25.9              | 25.5                  | 38.3    |
|                       | 91.6              | 50.6                  | 79.7    |
|                       | 98.0              | 82.3                  | 93.8    |
|                       | -                 | 96.3                  | -       |
|                       | -                 | 96.5                  | -       |

*: Reading of per cent wilting was done every two days after treatments.

Table 3: Effect of the best treatment of AgNO₃ and sucrose on vase life and postharvest quality of rose cut flowers

| Treatments                | Vase life values (day) |
|---------------------------|------------------------|
| AgNO₃ 30 ppm              | 12.5 b                 |
| AgNO₃ 30 ppm + 3% sucrose | 14.5 a                 |
| Sucrose 3%                | 7 c                    |
| Control treatment         | 5 d                    |

*: Letters explain the significant differences between means, according to Duncan multiple range p = 0.05.

Effect of the best treatment for AgNO₃ and sucrose on vase life and postharvest quality of rose cut flowers: Results of Table 3 showed that treatment by AgNO₃ at 30 ppm prolonged the vase life of rose cut flowers with or without sucrose compared to control. When sucrose was added to 30 ppm AgNO₃ the vase life was extended to 12 days compared to 9 days without sucrose. However, sucrose at 3% extended the vase life by 7 days compared to 6 days only in control (Table 3).

Chlorophyll content: The previous treatments lead to a considerable delay in degradation of Chl a and Chl b compared to control (Table 4). The concentration of chlorophyll a was higher than chlorophyll b at any point of time throughout the vase life. When flowers were treated with AgNO₃ 30 ppm chlorophyll content on the 1st day was 0.672, 0.330 mg 1⁻¹ weight for chl. a and chl. b, respectively (Table 4).

Carbohydrate content: Data of Table 5 and 6 show that fructose, glucose and sucrose were the main soluble carbohydrates in petals and stems of cut roses. Fructose was the major component in the petals as well as in stems but, generally, its value was higher than in stems. Sucrose contents in petals and stems were lower than those of glucose.

The carbohydrate content significantly increased as a result of using 30 ppm AgNO₃+3% sucrose till the 3rd day then sharply decreased on the 5th day at which the vase life of control was terminated.

![Fig. 1](image_url)
Table 4: Effect of AgNO3 with or without sucrose and sucrose alone on chlorophyll content for rose cut flowers.

| Treatments               | Days of determination of chl. a | Chl. b | Days of determination of chl. a | Chl. b | Days of determination of chl. a | Chl. b | Days of determination of chl. a | Chl. b |
|--------------------------|---------------------------------|--------|---------------------------------|--------|---------------------------------|--------|---------------------------------|--------|
| AgNO3 30 ppm             | 0.727                           | 0.384  | 2.402                           | 0.541  | 1.757                           | 0.521  |
| AgNO3 30 ppm + sucrose 3%| 0.743                           | 0.400  | 1.912                           | 0.482  | 2.299                           | 0.407  |
| Sucrose 3%               | 0.733                           | 0.410  | 1.421                           | 0.743  | 0.687                           | 0.186  |
| Control treatment        | 0.727                           | 0.384  | 2.940                           | 0.406  | 0.596                           | 0.070  |

1: mg 1⁻¹ fresh weight

Table 5: Effect of AgNO3 with or without sucrose and sucrose alone on carbohydrate content (in mg 1⁻¹ dry weight) for petals of rose cut flowers

| Treatment               | Fructose | Glucose | Sucrose | Fructose | Glucose | Sucrose | Fructose | Glucose | Sucrose |
|-------------------------|----------|---------|---------|----------|---------|---------|----------|---------|---------|
| AgNO3 30 ppm            | 1.48     | 1.22    | 0.04    | 1.58     | 1.24    | 0.07    | 2.73     | 1.91    | 0.76    |
| AgNO3 30 ppm + sucrose 3%| 2.99     | 2.01    | 0.89    | 2.27     | 1.79    | 1.03    | 3.71     | 2.03    | 1.93    |
| Sucrose 3%              | 3.35     | 1.97    | 0.93    | 2.99     | 1.55    | 0.22    | 1.37     | 1.08    | 0.32    |
| Control                 | 0.33     | 0.09    | 0.16    | 1.11     | 0.30    | 0.18    | 3.71     | 1.97    | 0.91    |

Table 6: Effect of AgNO3 with or without sucrose and sucrose alone on carbohydrate content (in mg 1⁻¹ dry weight) for stems of rose cut flowers

| Treatment               | Fructose | Glucose | Sucrose | Fructose | Glucose | Sucrose | Fructose | Glucose | Sucrose |
|-------------------------|----------|---------|---------|----------|---------|---------|----------|---------|---------|
| AgNO3 30 ppm            | 4.00     | 0.31    | 1.40    | 4.09     | 0.33    | 1.46    | 5.17     | 0.62    | 1.76    |
| AgNO3 30 ppm + sucrose 3%| 1.35     | 1.55    | 0.03    | 1.44     | 1.67    | 0.05    | 1.77     | 4.58    | 0.09    |
| Sucrose 3%              | 1.37     | 1.08    | 0.32    | 1.66     | 1.23    | 0.44    | 2.00     | 1.87    | 0.61    |
| Control                 | 0.91     | 0.30    | 0.08    | 0.99     | 0.60    | 0.11    | 1.01     | 0.18    | 0.24    |

The concentrations of fructose, glucose and sucrose in rose petals were 0.65, 0.18 and 0.26 mg g⁻¹ dry weight in controls at the end of the experiments (Table 5). At the same time values of these sugars in mg g⁻¹ dry weight when petals were treated with 30 ppm AgNO3 and 30 ppm AgNO3+ sucrose 3% and sucrose 3% alone were 1.96, 1.26 and 0.17, respectively (Table 5).

While stem contents of the previous sugars increased at the beginning of the experiment, then decreased towards the end of the experiment compared to control (Table 6).

**DISCUSSION**

Silver nitrate (AgNO3) is very potent inhibitors of ethylene action in plant tissues. The treatment of AgNO3 may decrease the ethylene production by rose cut flowers tested in comparison to control. It is also provides some antimicrobial activity inside the plant tissues, thus beneficial for ethylene sensitive flowers such as carnation (Nowak and Rudnicki, 1990). This might explain the effective role of AgNO3 in prolonging the vase life of rose cut flowers (Table 1). In addition, under AgNO3 treatment the percentage of wilting, chlorophyll and carbohydrate degradation was minimized and as a consequence, the vase life was extended (Table 2). These result are in harmony with the result of Singh and Tiwari (2002); Harode et al. (1993) and Reddy et al. (1988).

It is well known that sucrose supply increases the longevity of many cut flowers, since sucrose can act as a source of nutrition for tissues approaching carbohydrate starvation, flower opening and subsequent water relations (Kuiper et al., 1995), similar finding were obtained by Lalonde et al. (1999); Nichols (1973); Ichimura (Ichimura, 1998) and Downs (1988).

Concerning the role of sucrose with AgNO3 in the previous results show that adding sucrose extended the vase life and improved the quality of rose cut flowers. The data on of chlorophyll and carbohydrate contents show the positive role of AgNO3 with or without sucrose and sucrose individually on preserving the leaves in good condition by lowering the per cent of wilting and inhibiting the chlorophyll and carbohydrate degradation, similar result were obtained by Serek et al. (1996). Even in absence of exogenous ethylene, the life of the lowers was significantly increased by inhibiting ethylene action. As a similar tendency, Bartoli et al. (1997) and WeiMing et al. (1997) reported that.
CONCLUSION

A significant improvement in vase life of rose cut flowers was occurred when treated with 30 ppm silver nitrate and the effect was further improved when silver nitrate at 30 ppm combined with 3% (w/v) sucrose which attained the best result compared to other concentrations of sucrose. Also the per cent of wilting was minimized, beside chlorophyll as well as carbohydrate degradation had been retarded during the postharvest life as the result of using this combination treatment.

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