American-Eurasian J. Agric. & Environ. Sci., 14 (4): 329-335, 2014
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2014.14.04.12323

# Effect of Pulsing Solution and Packaging Type under Exogenous Ethylene on Physiological Characteristics and Post Harvesting Quality of Cut Roses (*Rosa hybrida*)

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**Abstract:** Roses (*Rosa hybrida*) are belong to the family of *Rosaceae* which are native to diverse habitats in the Northern hemisphere are the most important ornamental plants. The flowers are marked either as potted plants or cut flowers. Having long lasting life period of cut flowers will effect to their attraction to people for their natural beauty and appearances and help the socio-economic value of flowers remain intact. Thus, this study was initiated to evaluate the effectiveness of pulsing solution, packaging type and ethylene on physiological characteristics of fresh cut roses that effect on their postharvest life and quality. Results show that unlike higher protein content in glass chamber (2.13), the production of ethylene was higher (701.4) compare to polyethylenamid chamber. Therefore, by reducing the dry weight (3.96) and vase life of cut flowers, the glass chamber seems not supportive as polyethylenamid to increase the vase life. A moderate treatment with exogenous ethylene (1-10 $\mu l^{-1}$) and STS pre-treatment under polyethylenamid coverage was suitable condition for extending the rose vase life longevity, saving their natural appearance and delaying senescence.

**Key words:** Rose · Post harvest · Packaging · Pulsing solution · Ethylene

## INTRODUCTION

Roses (*Rosa hybrida*) are belong to the family of *Rosaceae* which are native to diverse habitats in the Northern hemisphere are the most important ornamental plants. There are 120 species belonging to the genus Rosa (de Vries and Dubois 1996). They are found in the northern temperate climate zones and in the tropical and subtropical worldwide (Zlesak 2006; Bayleyegn *et al*. 2012). Commercially, rose flowers are marked either as potted plants or cut flowers. Under normal conditions, the beauty and attractiveness of cut flowers could remain only for a few days. However, having long lasting life period of cut flowers will effect to their attraction to people for their natural beauty and appearances and help the socio-economic value of flowers remain intact. Most of the commercial cut roses will last in the vase for 10 or more days, as long as they are properly handled. Hence using different biocides and preservative solutions can help to explore possibilities of extending vase life. Therefore, controlling and saving the aesthetic qualities, fragrance and appearance of cut flowers will be encouraged to buy them and increase the market values. (Chapman and Austin-brown 2007; Tsegaw *et al*. 2011).

With increasing demand of floriculture products in and out of the country, there is a need to provide suitable transport system and postharvest conditions. Moreover, due to physiological and pathological effects during the postharvest handling approximately 20% of the total fresh products are lost in between the time of transportation. Therefore, by growing the volume of export of floricultural products the research focuses on postharvest methods are in demand. (Usman Farooq *et al*. 2004; Panhwar 2006; Tsegaw *et al*. 2011).

The blockage of xylem vessels by air and microorganisms that might causes xylem occlusion is one of the major problems in cut flowers shelf life. There are some commercial cut flower preservatives in the market,

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like *8-hydroxyquinoline sulphate* (8HQS), that is very effective germicide which is currently used as preservatives and antimicrobial agent in many floral industries (Nowak and Rudnicki 1990; Ketsa *et al*. 1995) which is known to increase water uptake (Reddy *et al*. 1995). A pulse treatment of sucrose and/or silver thiosulfate (STS) was effective in maintaining the vase life of cut sweet pea flowers (Ichimura and Hiraya 1999; Sexton *et al*. 1995). Meir *et al.* (1995) reported that mini-gladiolus cut spikes, together with sucrose plus STS pulsing, showed potential advantages of extending vase life and maintaining flower quality. Moreover, the postharvest quality of cut *Heuchera sanguinea* was significantly improved followed by increasing of its vase life by pulsing the inflorescence with STS for 4 h followed by placing the stems in a sucrose solution contain 8-hydroxyquinoline sulphate (Han 1998). However, reports are few on the effects of the pulse treatment of sucrose and/or STS on improving the vase life of cut rose flowers (Liao *et al*. 2000). Ethylene negatively is an important factor in the shelf life of cut flowers (Joyce and Poole 1993; Elgar *et al*. 1999; Han *et al*. 2003), as it accelerates flower abscission and leaf yellowing (Joyce and Poole 1993; Cameron & Reid 2001; Celikel *et al*. 2002). Silver thiosulphate (STS) was shown as most effective bactericide and an inhibitor to ethylene production and action (Nowak and Rudnicki, 1990; Gendy and Hamad 2011).

Reid *et al.* (1989) found that various cut rose cultivars shown a range of responses, such as, inhibition of opening, acceleration of opening, abnormal opening, petal and leaf abscission and loss of petal gloss to ethylene treatment. Treatments with anti-ethylene compounds, like STS (silver thiosulfate), can effectively protect flowers against exogenous ethylene (Serek *et al*. 1995; Serek and Trolle, 2000; Redman *et al*. 2002; Hunter *et al*. 2004). The effect of 1 mM STS for 2 h was shown to reduce 24% in Flower abscission by Chamani *et al*. (2005). Thus, this study was initiated to evaluate the effectiveness of pulsing solution, packaging type and ethylene on physiological characteristics of fresh cut roses that effect on their postharvest life and quality.

## MATERIALS AND METHODS

The research project was conducted to study the vase life of cut rose flower cv Amada with preservative materials used as pulsing solution contain 8-hydroxyquinoline sulphate (8HQS) and silver thiosulfate (STS) under room conditions (23 ± 1°C) with normal day light and natural ventilation at the Post Harvest Research Laboratory, Department of Plant Production, Imam Khomeini Higher Educational Center Karaj, Iran, during the year 2012. Flowers were obtained from commercial greenhouse located 70 Km away from university campus (Shrifabad region). Cut roses at tight bud stages were picked and brought immediately to the postharvest laboratory in a cold room (4°C). Stem ends were re-cut under water to remove air emboli and then placed into vases containing preservative materials and distilled water.

**Experimental Design and Treatments:** The experimental unit consisted of five flower stems in three replications. To study the effect of different pulsing solutions on the vase life of the cut flower stems, the experiments were divided into two groups. In first group, Flowers treated with ethylene at 1, 10 and 100 µl $l^{-1}$ for 48 h at 24 °C (Reid *et al*. 1989) and preserved solution contained 8HQS

Table 1: Analysis of variance of different treatments

| Treatments | DF | Protein content | Eta | FW | DW |
|---|---|---|---|---|---|
| PT | 1 | 0.073 * | 1706302.1 ** | 0.003 ns | 0.529 * |
| STS | 1 | 0.400 ** | 18644.1 ** | 0.105 ns | 13.846 ** |
| ET | 3 | 0.025 ns | 3426458.9 ** | 0.502 * | 0.238 ns |
| PT : STS | 1 | 0.001 ns | 103230.8 ** | 0.450 ns | 0.696 * |
| PT : ET | 3 | 0.023 ns | 1513015.5 ** | 0.029 ns | 0.247 ns |
| STS : ET | 3 | 0.007 ns | 17921.1 ** | 0.296 ns | 0.845 ** |
| PT : STS : ET | 3 | 0.038 ns | 103170.1 ** | 0.724 ns | 0.407 * |
| Error | 32 | 0.017 | 4615.2 | 0.163 | 0.128 |
| CV | | 6.2 | 13.3 | 3.9 | 8.8 |

* = $P < 0.05$, ** = $P < 0.01$

PT = packaging type, ET = ethylene, DF = degree of freedom, FW = fresh weight,

DW = dry weight

Table 2: The effect of packaging type on different longevity factors

| Packaging Type | Protein content | Eta | FW | DW |
|---|---|---|---|---|
| Glass | 2.13 [a] | 701.4 [a] | 10.26 [a] | 3.96 [b] |
| Polyethylene | 2.05 [b] | 324.3 [b] | 10.25 [a] | 4.17 [a] |

ET = ethylene, FW = fresh weight, DW = dry weight

Table 3: The effect of STS treatment on different longevity factors

| STS | Protein Content | ETa | FW | DW |
|---|---|---|---|---|
| ST0 | 2.18 [a] | 532.1 [a] | 10.21 [a] | 4.60 [a] |
| ST1 | 1.99 [b] | 493.2 [b] | 10.30 [a] | 3.52 [b] |

ET = ethylene, FW = fresh weight, DW = dry weight

Table 4: The effect of external ethylene on longevity factors

| ET | Protein Content | ETa | FW | DW |
|---|---|---|---|---|
| ET0 | 2.11 [a] | 235.3 [b] | 10.55 [a] | 4.06 [ab] |
| ET1 | 2.06 [a] | 252.6 [b] | 10.11 [b] | 4.26 [a] |
| ET10 | 2.04 [a] | 249.3 [b] | 10.25 [ab] | 4.00 [ab] |
| ET100 | 2.14 [a] | 1314.3 [a] | 10.12 [b] | 3.93 [b] |

ET = ethylene, FW = fresh weight, DW = dry weight

Table 5: The effect of STS on exogenous ethylene

| ET | STS | PC | ETa | FW | DW |
|---|---|---|---|---|---|
| ET0 | ST0 | 2.23 [a] | 245.2 [b] | 10.71 [a] | 4.23 [cd] |
| | ST1 | 1.99 [cd] | 225.5 [b] | 10.38 [a] | 3.90 [d] |
| ET1 | ST0 | 2.14 [ab] | 254.2 [b] | 10.06 [a] | 5.01 [a] |
| | ST1 | 1.98 [cd] | 251.0 [b] | 10.15 [a] | 3.50 [e] |
| ET10 | ST0 | 2.14 [ab] | 240.2 [b] | 10.04 [a] | 4.54 [bc] |
| | ST1 | 1.93 [c] | 258.3 [b] | 10.46 [a] | 3.46 [e] |
| ET100 | ST0 | 2.20 [ab] | 1390.8 [a] | 10.02 [a] | 4.62 [b] |
| | ST1 | 2.07 [bc] | 1237.8 [a] | 10.22 [a] | 3.24 [e] |

PC = protein content, ET = ethylene, FW = fresh weight, DW = dry weight

Table 6: The interaction effect of different treatments on longevity factors

| PT | STS | ET | PC | ETa | FW | DW |
|---|---|---|---|---|---|---|
| Glass | ST0 | ET0 | 2.25 [a] | 264.7 [e] | 11.26 [a] | 4.51 [b] |
| | | ET1 | 2.17 [ab] | 254.0 [e] | 10.00 [c] | 4.67 [b] |
| | | ET10 | 2.23 [ab] | 253.3 [de] | 10.00 [c] | 4.56 [b] |
| | | ET100 | 2.23 [ab] | 1927.0 [b] | 10.00 [c] | 4.71 [b] |
| | ST1 | ET0 | 1.95 [ab] | 229.3 [e] | 10.00 [c] | 3.41 [de] |
| | | ET1 | 2.05 [ab] | 271.3 [de] | 10.17 [c] | 3.22 [de] |
| | | ET10 | 1.89 [b] | 267.7 [de] | 10.47 [b] | 3.41 [de] |
| | | ET100 | 2.23 [ab] | 2144.0 [a] | 10.22 [c] | 3.15 [e] |
| polyethylene | ST0 | ET0 | 2.22 [ab] | 225.7 [e] | 10.17 [c] | 3.94 [c] |
| | | ET1 | 2.11 [ab] | 254.0 [de] | 10.12 [c] | 5.35 [a] |
| | | ET10 | 2.04 [ab] | 227.0 [e] | 10.08 [c] | 4.51 [b] |
| | | ET100 | 2.17 [ab] | 854.7 [c] | 10.05 [c] | 4.53 [b] |
| | ST1 | ET0 | 2.03 [ab] | 221.7 [e] | 10.77 [b] | 4.39 [b] |
| | | ET1 | 1.91 [ab] | 230.7 [e] | 10.13 [c] | 3.78 [cd] |
| | | ET10 | 1.98 [ab] | 249.0 [de] | 10.46 [bc] | 3.51 [cd] |
| | | ET100 | 1.92 [ab] | 331.7 [d] | 10.22 [c] | 3.32 [de] |

PT = packaging type, ET = ethylene, PC = protein content, FW = fresh weight, DW = dry weight

(200 mg/l). While, in the second group Flowers treated with ethylene, pulse-treated with 0.5 mM STS for 2 h at room temperature (24 °C) (Reid *et al*. 1980; Chamani *et al*. 2005) and preserved solution contained 8HQS. In the first set, the flowers were sealed in 30×30×34 cm (30 l volume) glass chambers and in the second set, the flowers were sealed in 30×30×34 cm (30 l volume) polyethylenamid chambers.

**Determination of Ethylene Production:** Ethylene production of enclosed flowers was measured by detaching the samples daily after treatment in airtight containers (30 ml). Two ml gas samples were taken from the headspace of the containers with a hypodermic syringe at room temperature. The ethylene concentration in the sample was measured by gas chromatograph (HP5890, Hewlett-Packard, Menlo Park, CA) using a flame ionization detector (FID). A stainless steel column (150 x 0,4 cm, packed with Hysep T), the column and detector temperatures of 70 and 350 °C, respectively and nitrogen carrier gas at a flow rate of 30 ml $min^{-1}$. Quantification was performed against an external standard and results were expressed on a fresh weight basis (plh−1) (Ferrante *et al*. 2012)

**Determination of Protein Content:** The determination of protein content in the leaves was made with the help of Bradford's (1976) method. 2 ml of Coomassie Brilliant Blue G-250 (CBB) solution in 85% orthophosphoric acid was added to 100 ìl of a diluted extract, with the extraction in phosphorate-potassium buffer (pH 7.0). After 10 minutes the absorbance was measured at a wavelength of 595 nm. Protein content was determined from a curve plotted for albumin (Janowska and Stanecka 2011).

**Relative Fresh Weight and Dry Weight:** The samples were weighed every two days until the end of the vase life. The flower samples were taken out of water for a very short time of 20 to 30 s. The fresh weight of each flower was measured using analytical balance (SW -1S with serial number SN 060713167). The fresh weight was expressed relative to the initial weight of sample flowers (Joyce and Jones, 1992). The volume of solution uptake was calculated by subtracting the volume of water evaporated from a flask of the same volume without cut flowers that of the total volume of water lost from the flask with cut flower sample (Chamani *et al*. 2005). The volume of water lost was calculated by subtracting the increase in fresh weight from the water uptake volume. 15 g of petals were taken for the determination of total dry weight by an oven at 70 °C for 48 h (Bayleyegn *et al*. 2012).

**Statistical Analysis:** In all experiments, flowers were arranged using a completely randomized design (CRD) in a controlled environment. For the ethylene experiment, 10 replications were used for each treatment and data were analyzed by one way ANOVA using Minitab® Release 13.2 (Minitab Inc.). Following ANOVA, the least significant difference (LSD) test at $P = 0.05$ was used to separate treatment means. For the STS experiment, three replications were used for each treatment and all data were analyzed by the general linear model ANOVA by Minitab® Release 13.2 (Minitab Inc.). Following ANOVA, treatment means were compared using the LSD test at $P = 0.05$. Statistical procedures were performed using the PC– SAS software package. Differences between means were determined using orthogonal comparisons or Student T-test.

## RESULTS AND DISCUSSION

Cut flowers depending on their species, cultivar, harvesting stage and cultivation conditions displaying various postharvest longevity reactions. The vase life of flowers is one of the criteria in assessing their quality. In this study the flowers were put in pulse solution content (8HQS) in the glass chambers compared with flowers were covered by polyethylenamid for the packaging type experiment. The protein content, ethylene production and also dry weight were shown significantly different (Table 1). The packaging type had significant effect on protein content ($P < 0.05$), ethylene production ($P < 0.01$) and dry weight ($P < 0.05$) (Table 1). Whereas, the fresh weight did not show any significant changes, therefore packaging type had no significant effect on cut flowers fresh weight (Table 1).

Proteolysis, the degradation of proteins, results the tissue senescence process. Any controlling factor that cause to decreasing this process can positively affect on vase life of cut flowers (Janowska and Stanecka 2011). Furthermore, ethylene production can effectively reduce the fresh and dry weight which results to progress of tissue senescence of cut flowers. Here, results shown that unlike higher protein content in glass chamber (2.13), the production of ethylene was higher (701.4) compare to polyethylenamid chamber (Table 2). Therefore, by reducing the dry weight (3.96) and vase life of cut flowers, the glass chamber seems not supportive as polyethylenamid to increase the vase life. To understand the affect of ethylene production on vase life longevity pulsing solution with STS (anti-ethylene treatment) has been studied. The fresh weight was not significantly changed, while, the other factors were significantly affected by anti-ethylene treatment ($P < 0.01$) (Table 1). Comparison of STS pre-treatment showed less factors level compare to un-treated samples. Though, they showed significant changes in protein content, ethylene production and dry weight (Table 3).

HQS is a well known germicide that has little effect in extending the vase life of cut flowers (De Stigter 1981; Ichimura & Hisamatsu 1999; Jones & Hill 1993; Larsen & Scholes 1966; Van Doorn *et al*. 1990). Here we found, the pulse treatment with only HQS solution compare to HQS together with anti ethylene (STS) showed higher level of parameters (Table 3). Ichimura *et al.* (1998) also indicated that using HQS has little effect on the vase life or climacteric ethylene production of cut flowers. Therefore, the effect of HQS on ethylene production was ignored and the vase life of the rose cut flowers was attributed to packaging type and STS. These results also found in previous studies in rose (Mor *et al*. 1984), chrysanthemum (Anju *et al*. 1999) and freesia (Kwon *et al*. 2000) by increasing the vase life of flowers with STS; combine with 8-HQS treatment. This combination has pronounced effect on vase life and flower quality in cut rose flower because of their effect on ethylene production and delaying on flower fresh weight loss. It also reduces dry weight that can relate to decrease protein content.

The study of ethylene treatment with increasing concentrations of ethylene (1, 10 and 100 $\mu l\ l^{-1}$) had no significant effect on protein content and dry weight, This results indicates that there were no significant protein content changes and weight losses under ethylene treatment (table 4); but indicated noticeable increase on ethylene production with $100 \mu l^{-1}$ concentration ($P < 0.01$) external ethylene and it also influenced on fresh weight ($P < 0.05$). The highest fresh weight was shown in absent of ethylene treatment. Reid *et al*. (1989) reported that the effect of exogenous ethylene ($0.5\ \mu l\ l^{-1}$) on rose flowers could be overcome by pre-treatment with STS at a rate of $0.5\ \mu mol\ stem^{-1}$. Elgar *et al.* (2003) reported that exposure of *Leucocoryne coquimbensis* inflorescences to $8\ \mu l\ l^{-1}$ ethylene for 24 h reduced its vase life from 10 to 5 days and pre-treatment with 1 mM STS for 2 h protected flowers, giving a vase life of 9.1 days. The result of this study cleared that the effect of exogenous ethylene in all experimental levels on rose flower could be changed by pre-treatment with STS in some parameters (Table 5), as it accelerates flower abscission and leaf yellowing (Joyce & Poole 1993; Cameron & Reid 2001; Celikel *et al*. 2002).

The results had been shown the same effect of exogenous ethylene. In addition, it was appeared the effect of ethylene concentration on treatment results, followed by reducing fresh weight as one of the senescence sign. Therefore, exogenous ethylene treatment with $100\mu l^{-1}$ indicated greater efficacy on reducing vase life cut flower rose in cv. Amada (Table 1 & 5).

The interaction effects of pulsing solution, packaging type and ethylene treatment during post-harvesting on protein content of cut rose flower cv Amada were not found to be significant, similarly had no significant effect on fresh weight of the flowers. However, they shown significant deference on ethylene production ($P < 0.01$) and dry weight ($P < 0.05$) of cut rose flowers (Table 6).

Prashanth and Chandrasekar (2010) found significant differences among different packaging treatments in response to pulsing solution and storage conditions and subsequent vase life period of cut gerberas. According to this study, the loss of vase life was showed in glass chamber in flowers pre-treated with STS under 100 $\mu l\ l^{-1}$ exogenous ethylene. Subsequently, in flowers without pretreatment under 100 $\mu l\ l^{-1}$ exogenous ethylene which were put in glass chamber. Therefore, packaging type and concentration of exogenous ethylene treatment were the most important factors influenced on vase life.

## CONCLUSION

In the present study, we found that the interaction effect of different factors was not significantly influenced on vase life cut rose flowers. The single factor treatments were effectively influenced on flower vase life. The high concentrations of exogenous ethylene suppress the effect of STS pre-treatment. A moderate treatment with exogenous ethylene (1-10 µl) and STS pre-treatment under polyethylenamid coverage was suitable condition for extending the rose vase life longevity, saving their natural appearance and delaying senescence.

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