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Full Length Research Paper

Application of *Carum copticum* and *Satureja hortensis* essential oils and salicylic acid and silver thiosulfate in increasing the vase life of cut rose flower

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The aim of this study was to investigate the potential application of *Carum copticum* and *Satureja hortensis* essential oils and salicylic acid (SA) and silver thiosulfate (STS) for preservation postharvest quality sensors of rose cut flowers. In this study, cut rose flowers were treated with alone application of this substances and their combination. Results showed that the pH of vase solution in cut flowers treated with plant essential oils were lower than other treatments. Fresh weight (%), solution uptake (cm^3) and the vase life of cut roses significantly affected by essential oil treatment, in comparisons with control (sucrose 4%). It is distinguished that STS treatment had the best effect on fresh weight (%), followed by *C. copticum* oil at 500 ppm concentration, sucrose 4% (control) and SA treatment, respectively.

Key words: Rose cut flower, *Carum copticum*, *Satureja hortensis*, salicylic acid, silver thiosulphate, vase life.

INTRODUCTION

Cut flower consumption is rapidly increasing in many countries all over the world. Cut roses are desirable for use as cut flowers because of their wide range of petal colors and fragrances. This is very promising for the cut-flower industry in which we are all operating (Pertwee, 2000; AIPH, 2003). However, the vase life of cut flowers limited by some factors such as senescence, weight loss, decays, air emboli and EST (Van, 1990; Jones and Hill, 1993; Huang et al., 2002). Within these factors decays caused by bacteria, which found in high level in vase solutions used by growers, wholesalers and consumers to hydrate the cut flowers, is one of the most important factors affect the vase life of cut flowers. Because these microorganisms usually enter and block stem xylem vessels and thereby reduce rates of water supply to flowers (Zagory and Reid, 1986; Van and D'hont, 1994; Van, 1997). In addition, it is documented that nutrient solutions that usually used for extending the vase life of cut roses may be infected by *Botrytis cinerea* Pers. Fr. and caused gray mold in harvested flowers (Jarvis, 1977; De et al., 2003). This view supported by the finding that addition of antimicrobial agents such as 8-hydroxyquinoline sulphate (8-HQS) in the storing solution is one of principle methods for reduction of microbial population and extending the longevity of cut flowers (Gilman and Steponkus, 1972; KiCheol et al., 1997; Hassan, 2005).

Ethylene concentration in the composition of ambient atmosphere is another factor that affects vase life of cut flowers. Ethylene usually causes yellowing leaves, flowers or petals falling, irregular opening buds and eventually mortality cut flowers (Ichimura and Suto, 1999; Hassan, 2005). So a cut flower grower is able to appropriate management of ethylene concentration in the atmosphere increase longevity of cut flowers. Since 1970s, application of silver thiosulfate (STS) $[Ag(S_2O_3)^2]^3$, as ethylene binding inhibitor, is the best effective method that used for increase of vase life of cut flowers (Reid et al., 1999). In the recent years,

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Abbreviations: SA, Salicylic acid; **STS,** silver thiosulfate; **SS,** sucrose solution; **CRD,** completely randomized design; **ANOVA,** analysis of variance.

application of STS is restricted because it is contains silver as heavy metal that is toxic for environment. Therefore, researchers trend to find new safe or low toxic materials for preservation and increase of the vase life of cut flowers (Shimamura et al., 1997).

Application of natural materials such plant essential oils and salicylic acid (SA) could be tested as new safe alternatives for improving the postharvest quality and vase life of cut flowers. Essential oils are natural mixtures of hydrocarbons and oxygen (alcohols, aldehydes, ketones, carboxylic acids, esters, and lactones) containing organic substances of plants. Essential oils, their constituents and derivatives have a long history of application as antimicrobial agents in the areas of food preservation and medicinal antimicrobial production (Voda et al., 2003). Recently many works carried out about the application essential oils as antimicrobial agents under *in vitro* and *in vivo* condition and indicated that essential oils could increase postharvest quality of many horticultural crops such as tomato, table grape and kiwifruit (Abdolahi et al., 2010a, b; Jalili Marandi et al., 2011; Shirzad et al., 2011). SA is a phenolic derivative, distributed in a wide range of plant species. It is a natural product of phenylpropanoid metabolism. Decarboxylation of transcinnamic acid to benzoic acid and its subsequent 2-hydroxylation results to SA (Hayat et al., 2007). In addition, the potential of SA in preservation of pear, apple and rose cut flowers studies (De Capdeville et al., 2003; Tian et al., 2006; Yu and Zheng, 2006).

Therefore, the objective of this study is the application of plant essential oils and salicylic acid, as natural materials, only or in combination with STS and sucrose for prolonging the vase life of cut rose flowers.

MATERIALS AND METHODS

Chemicals, plant material and treatment

Sucrose (Scharlua, Spain), SA (Scharlua, Spain) and silver thiosulphate (Merk, Germany) were purchased, respectively. The aerial parts of summer savory (*Satureja hortensis* L.) at flowering stage and ajowan (*Carum copticum* L.) fruits at ripening stage were harvested, air dried and then submitted to hydrodistillation in a Clevenger-type apparatus for 3 h. The extracted essential oils dried over anhydrous sodium sulfate.

Cut rose (*Rosa hybrida* L. cv. First Red) flowers were purchased from a commercial grower at normal harvest maturity (sepals starting to reflex) and immediately transported to laboratory of Department of Horticulture, Faculty of Agriculture, Urmia University and used for experiments.

Treatment of cut flowers

Flower stems were trimmed to 40 cm, all leaves except for the upper three were removed and the end of cut flowers disinfected with solution of 1% sodium hypochlorite for 2 min. Different treatment solutions were prepared and then cut flowers treated with different solutions. 15 treatments carried out in this study on cut flowers include: (1) Sucrose solution 4% (SS) as control; (2) SA 1.5 mMol + SS; (3) STS 150 ppm + SS; (4) *C. copticum* EO (500 ppm) + SS; (5) *C. copticum* EO (1000 ppm) + SS; (6) *S. hortensis* EO (500 ppm) + SS; (7) *S. hortensis* EO (1000 ppm) + SS; (8) *C. copticum* EO (500 ppm) + SA 1.5 mMol + SS; (9) *C. copticum* EO (1000 ppm) + SA 1.5 mMol + SS; (10) *S. hortensis* EO (500 ppm) + SA 1.5 mMol + SS; (11) *S. hortensis* EO (1000 ppm) + SA 1.5 mMol + SS; (12) *C. copticum* EO (500 ppm) + STS 150 ppm + SS; (13) *C. copticum* EO (1000 ppm) + STS 150 ppm + SS; (14) *S. hortensis* EO (500 ppm) + STS 150 ppm + SS; (15) *S. hortensis* EO (1000 ppm) + STS 150 ppm + SS. Three cut flowers were placed in a glass vessel with 10 ml treatment solution. Three flowers were used for each treatment. The cut flowers were maintained at 22 ± 1°C, 60 to 70% relative humidity, and a 16 h photoperiod under 10 µmol m^{-2} s^{-1} irradiance from cool-white fluorescence lamps.

Determination of quality sensors

Vase life was the period from the time of harvest to the time when 50% of the petals lost turgor and wilted. The relative fresh weight (%) of cut flowers and the solution uptake (cm^3 day^{-1}) were measured daily. The pH of treatment solution and stem diameter of flower at harvest and in the end of storage (when 50% of flowers welted) measured.

Statistical analysis

Statistical analyses of the data were performed with SPSS statistical software using completely randomized design (CRD) with 3 replicates. Data were subjected to analysis of variance (ANOVA) and mean differences were established by Duncan's test ($P < 0.05$).

RESULTS AND DISCUSSION

In this study the effect of *S. hortensis* and *C. copticum* essential oils, SA and STS only and their combinations on postharvest quality of cut rose flowers was investigated. Measurement of pH of vase solutions, in initial and end of assay showed that the essential oil preservative solutions had lower pH levels in comparison with STS and SA (Table 1). It is determined that the pH of holding solution had significant effect on longevity of cut flowers. Because enzymes involved in polymerization processes leading to deposition of lignin and suberin are inhibited at low pH (Vámos, 1981). Therefore, it could be speculated that one reason for high effectiveness of plant essential oils in the improvement quality of sensors of cut roses such as fresh weight (%), solution uptake (cm^3) and vase life may be related to their property in induction of low pH in vase solution.

Essential oils treatment had not significant effect on the stem diameter in oil-treated cut flowers, in comparison with control (sucrose 4%) (Table 2). But fresh weight (%), solution uptake (cm^3) and the vase life of cut roses significantly affected by essential oil treatment, in comparisons with control (sucrose 4%). It is distinguished that STS treatment had the best effect on fresh weight (%), followed by *C. copticum* oil at 500 ppm concentration, sucrose 4% (control) and SA treatment,

Table 1. The effect of different treatments on the pH of vase solution prepared for rose cut flowers in the start and the end of assay.

Treatment	Initial pH	Final pH
Sucrose (4%)	5.2	4.06
STS	7.81	5.73
SA	10.35	5.66
S. hortensis (500 ppm)	3.19	4.08
S. hortensis (1000 ppm)	3.14	4.42
C. copticum (500 ppm)	3.15	3.98
C. copticum (1000 ppm)	3.25	3.77
S. hortensis (500 ppm) + STS	4.13	5.02
S. hortensis (1000 ppm) + STS	3.86	5.06
C. copticum (500 ppm) + STS	4.37	5.1
C. copticum (1000 ppm) + STS	3.72	5.47
S. hortensis (500 ppm) + SA	7.61	3.67
S. hortensis (1000 ppm) + SA	7.28	3.73
C. copticum (500 ppm) + SA	7.42	3.99
C. copticum (1000 ppm) + SA	6.65	3.76

Table 2. The effect of essential oils, SA and STS treatments on stem diameter, fresh weight (%), solution absorption (cm^3) and vase life of rose cut flowers.

Treatment	Stem diameter	Fresh weight (%)	Solution uptake (cm^3)	Vase life (day)
Sucrose (4%)	83.6^{a}	83.2^{ab}	1.5^{b}	19^{b}
S. hortensis (500 ppm)	82.9^{a}	71.6^{c}	0.9^{d}	18^{c}
S. hortensis (1000 ppm)	82.3^{a}	73.6^{b}	1.2^{c}	17^{d}
C. copticum (500 ppm)	79.2^{a}	85^{a}	2.7^{a}	20^{a}
C. copticum (1000 ppm)	85^{a}	75.6^{b}	1^{c}	18^{c}
SA	84.3^{a}	81.8^{b}	3.4^{a}	20^{a}
STS	83.1^{a}	85.3^{a}	3.2^{a}	21^{a}

The means followed by same symbol in each column are not significantly different according to Duncan's multiple comparison tests ($P < 0.05$).

respectively. In addition, the cut roses treated with SA, STS and *C. copticum* essential oil at 500 ppm concentration had the highest solution uptake (cm^3) and vase life, respectively (Table 1). Also, when *C. copticum* oil at 500 ppm concentration combined with STS and SA showed the highest fresh weight (%) in comparison with other combined treatments and sucrose 4% (control). On the other hand, the effectiveness of STS, in combination with essential oils, in maintenance fresh weight (%) of cut flowers was higher than SA, in combination with essential oils (Figure 1).

The results of this study were in agreement with those of previous studies which showed that addition of STS in holding solution had positive effect on vase life and quality of cut flowers; for example, De et al. (1996) showed that STS and sucrose containing solution showed maximum beneficial effects on longevity of cut rose flowers. Pulsing cut rose flowers with STS + 10% sucrose inhibited the ethylene synthesis and improved the postharvest quality (Burzo and Dobrescu, 1995). Also in accordance to our results, it is distinguished that the rate of fresh weight decline was slowed down in the cut roses treated with STS (Song et al., 2001; Chikkasubbanna and Yogitha, 2002). STS, as a known inhibitor of ethylene action, has become an essential tool for delaying the senescence of cut flowers. It is distinguished that STS inhibited chlorophyll, soluble protein and sugar losses during chrysanthemum senescence (WeiMing et al., 1997). In addition, the silver ion available in the STS had bactericidal property and reduced the frequency of bent necks and improved the vase life of cut roses (Torre and Fjeld, 2001).

Positive efficacy of plant essential oils in this study could be attributed to their antimicrobial activity that act as biocide in the holding solution and reduce the bacterial population in the vase solution of cut flowers and as a

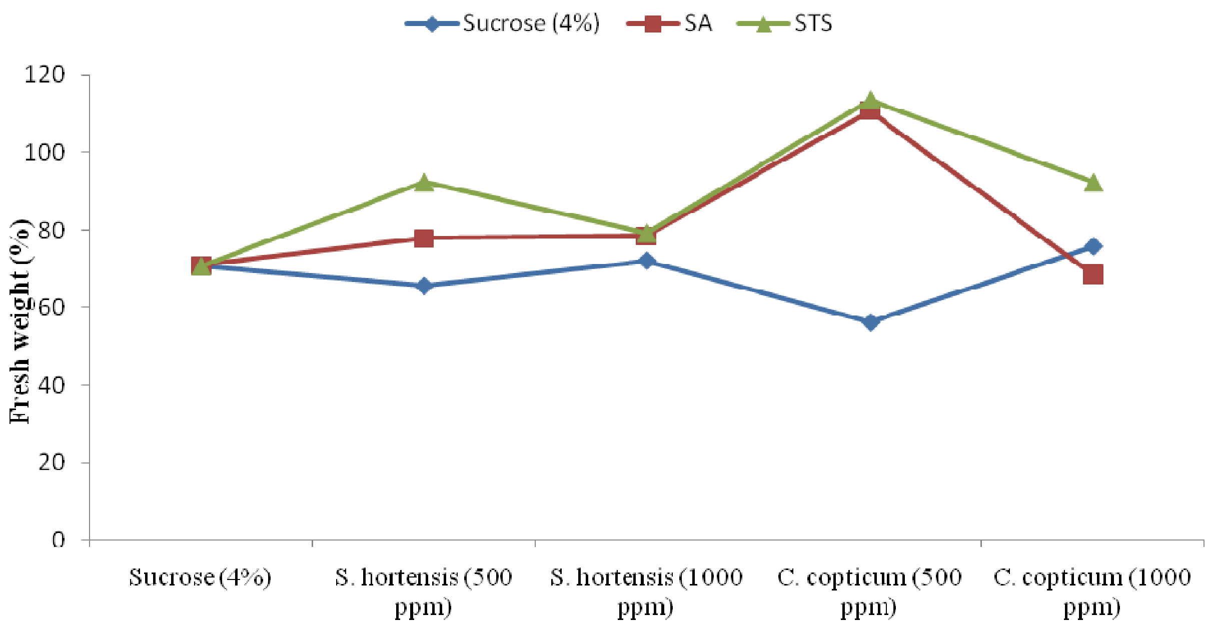

Figure 1. The effect of different essential oil, sucrose (4%), SA and STS treatments on fresh weigh (%) in the cut roses. Means of treatments with the same letter are not significantly different according to Duncan's multiple ($P < 0.05$).

result increase the vessels conductivity, water uptake and longevity of cut roses. Antimicrobial property of essential oils was well documented for centuries and in the recent years several studies for evaluation of their potential in use as natural antimicrobials in food and drug industries carried out (Burt, 2004). Also, it is distinguished that the antimicrobial activity of essential oils could be related to their composition that there has direct correlation between components available in the essential oils and their activity (Nychas, 1995; López-Malo et al., 2002). Farrag et al. (1989) reported that antimicrobial activity of essential oils can be attributed to phenolic compounds, followed by alcohols, aldehydes, ketones, ethers and hydrocarbons.

Also, the results of our study were accordance with (Solgi et al., 2009) that showed adding of thymol and carvacrol to vase solution increased relative fresh weight and solution uptake of gerbera cut flowers. It is showed that carvacrol and thymol, as phenolic compounds, were the major components available in the *S. hortensis* and *C. copticum* oil, respectively (Abdolahi et al., 2010a, b). On the other hand, some authors believed that not only major components of essential oils but all of compounds available in the essential oils affect their antimicrobial activity. They showed that there has synergistic correlation between activities and composition of essential oils (Edris and Farrag, 2003; Bagamboula et al., 2004). SA is endogenous plant growth substance that plays key roles in plant growth and development, and responses to environmental stresses. In addition, can result in induction of defense responses and provide protection for plants from pathogen-attack (Delaney et al., 1994). For example, Yu and Zheng (2006) and Tian et al. (2006) reported that SA treatment had a good potential in reduction of postharvest diseases on apple and pear fruits. Moreover, De et al. (2003) evaluated the effect of pulsing rose cv. Kiss with solutions of citric acid, salicylic acid, sucrose, calcium sulfate, and STS on disease severity and vase life of cut roses. They opined that pulsing with STS and calcium sulfate consistently reduced disease progress and increased the vase life of cut flowers. In this study, SA had positive effect in vase life and quality properties of cut rose flowers which we speculated that this efficacy of SA may be related to its potential to initiation of defense responses in the flowers.

Conclusion

Based on our study and the previous results, it could be concluded that STS treatment had higher benefit effect to improvement of postharvest quality of the flower crops in comparison with plant essential oils and SA treatments. In addition, essential oils and SA showed good preservative effects on cut roses and in the future studies different concentration or different methods should be evaluated for use their benefits for increasing the longevity of cut flowers.

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