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Effect of Ethanol and Essential Oils on Extending Vase-life of Carnation Cut Flower (*Dianthus caryophyllus* cv. 'Yellow Candy')

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Abstract

The aim of the present study was to evaluate the effects of ethanol and essential oils of three medicinal plants namely Thyme (*Thymus vulgaris* L.), Summer savory (*Satureja hortensis* L.) and Ajwain (*Carum copticum* L.) on extending carnation (*Dianthus caryophyllus*) vase-life. For this purpose three individual trials were conducted using a completely randomized block design with three replications. In the first trial, the effect of 4% ethanol (v/v) as a continuous or pulse treatment was determined. The results showed that although both application methods increased vase-life and marketability of carnation, it was statistically non significant. In the second trial, the effects of selected essential oils at the concentration of 100, 150 and 200 ppm were investigated. All essential oils prolonged carnation vase-life. Summer savory essential oil (100 ppm) showed the highest effect (increasing 4.4 days) in comparison to the control. In the third trial, the interaction between ethanol and the essential oils was studied. Results showed there is no significant difference between application of essential oils alone and in combination with ethanol. The highest fresh weight was observed in cut flowers treated with Summer savory essential oil at 100 ppm after 6 days which was double compared to the control. According to the results of this research it is concluded that essential oils, (natural, safe and biodegradable compounds) as novel alternative materials are suitable for prolongation of carnation vase-life.

Keywords: essential oils, cut flower, marketability, medicinal plants, vascular blockage

Introduction

Carnation is one of the most important cut flowers over the world with a worthy place among the users. Carnation has the highest economic importance value in the floricultural industry for decoration and adornment. The vase-life of carnation cut flowers is varying among various species and cultivars. It is one of the most valuable characteristics in determination of quality, satisfying consumer preferences and the commercial value (Nukui *et al.*, 2004; Onozaki *et al.*, 2001). Ethylene gas, a senescence accelerating agent, with vascular blockage which is caused by accumulation of bacteria in stem base or vase solution reduces vase-life of carnation cut flowers (Van Doorn *et al.*, 1994; Woltering and Van Doorn, 1988). Marketability as a qualitative factor in vase-life is also important. Use of preserving substances in vase solution is a widely used method for increasing the vase-life. One of the preserving agents is ethanol (Et) that inhibits ethylene synthesis and reduces sensitivity of flowers to ethylene (Van Doorn, 1998; Wu *et al.*, 1992). In lisianthus (*Eustoma grandiflorum* Mriachii cv. 'Blue') addition of 2% Et and 2.5% sucrose in the preserving solution increased the vase-life of lisianthus cut flowers (Frokhzad *et al.*, 2005). Application of Et at different concentrations also extended vase-life in Bougainvillea (Sharif Hossain *et al.*, 2008) and chrysanthemum cut flowers (Petridou *et al.*, 2001). Massantini *et al.* (1995) showed that the application of Et vapor on tomato (*Lycopersicon esculentum* Mill. cv. 'Romanesco') fruits delayed ripening through inhibition of ethylene synthesis. It is believed that Et inhibits conversion of ACC into ethylene (Heins and Blakely, 1980; Wu *et al.*, 1992).

Essential oils (EOs), organic natural substances, are safe and environmentally friendly that have strong antimicrobial properties against some pathogens. These antibacterial properties are attributed to the high levels of phenolic compounds such as carvacrol, thymol and eugenol (Lambert *et al.*, 2001; Mihajilov-Krstev *et al.*, 2010). EO has been recently used to control pathogens of fruits, vegetable and food (Burt, 2004; Thunberg *et al.*, 2002; Valero and Francés, 2006). It has also been reported that Iranian thyme (*Zataria multiflora* Bioss.) and thyme (*Thymus vulgaris* L.) EOs are used in preserving solution for extending the vase-life of gerbera (*Gerbera jamesonii* cv. 'Dune') cut flower (Solgi *et al.*, 2009). There is no enough information on effect of EOs on vase-life of carnation cut flowers. Therefore, the aim of this study was to evaluate the effects of Et, Thyme, Summer savory and Ajwain EOs on extending *Dianthus caryophyllus* cv. 'Yellow Candy' cut flower vase-life.

Materials and methods

Carnation (*Dianthus caryophyllus* L. cv. 'Yellow Candy') flowers (Fig. 1.) were collected from a standard hydroponic greenhouse in Mashhad (36°17'44"N and 59°36'

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2"E), Iran. The flowers were picked up before blooming (Droillard *et al.*, 1987) early in the morning (at 7 am) and immediately transferred to the lab in plastic packages. Stems were trimmed to 30 cm and placed in the glass vials containing 300 ml of the test solutions. This study was carried out in three individual trials based on completely randomized block design. In the first trial, 4% Et were applied on carnation cut flowers as pulse (24 h) or continuous treatment. In the second trial EOs (Thyme, Summer savory and Ajwain) was added into preserving solution at the concentrations, of 100, 150 and 200 ppm. In the third trial 4% ET was applied on carnation cut flowers as pulse treatment (24h) and then the cut flowers transferred into solution containing EOs (100 ppm) recording. All the treated cut flowers were kept at 21±1°C and 60% relative humidity under continuous fluorescent light (47 µmol m^{-2} s^{-1}).

Fresh weights of cut flowers were measured every day. To measure fresh weight the following formula was used:

R.F.W. (%) = $(W_t/W_0) \times 100$

W_t represents the fresh weight of treated cut flowers after six days and W_0 is the initial fresh weight at the beginning.

The end of vase-life was defined as the time that flowers showed symptoms of wilting, loss and discoloration of the petals, whereas the marketability of cut flowers were determined by salability and consumer acceptance.

Each treatment was comprised three flowers and repeated three times. Statistical analysis of recorded data was accomplished using analysis of variance (ANOVA) using JMP4 statistical software. The mean values were then compared by least significant differences test at $p \leq 0.05$.

Fig. 1. Carnation (*Dianthus caryophyllus* L. cv. 'Yellow Candy') cut flower with pale yellow color

Results and discussion

Results of this study showed that application of Et, significantly increased vase-life of carnation cut flowers as compared to the control ($p \leq 0.05$). Although the effect of 4% Et as continuous in extending vase-life was higher than pulse treatment, the difference was statistically non significant. Marketability of Et treated cut flowers also showed

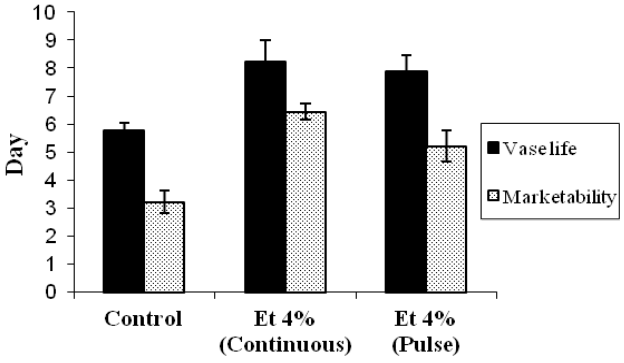

Fig. 2. Effect of continuous and pulse application of 4% Et on vase-life and marketability of carnation cut flowers (cv. 'Yellow Candy')

the similar results to the vase-life. In this case, the differences between 4% Et treated cut flowers and the control was significant ($p<0.5$) (Fig. 2). The present results are in agreement with those reported by Farokhzad *et al.* (2005) who used Et to prolong the vase-life of lisianthus cut flowers.

According to the obtained results, addition of EO to vase solutions in all concentrations increased the vase-life of carnation cut flowers ($p \leq 0.05$). Application of all essential oils were increased the vase-life at all concentrations except Thyme at 200 ppm which showed the negative effect (Fig. 3). Among these treatments Summer savory oil (100 ppm) had the greatest effect on extension of vase-life (4.4 day) as compared to the control (Fig. 2). Solji *et al.* (2009) confirm our results as they could increase the vase-life of gerbera cut flowers by adding herbal EOs into preserving solution.

It seems that all the treatments statistically increased carnation cut flowers vase-life as compared to the control ($p \leq 0.05$). Among EO treatments, Summer savory oil at the concentration of 100 ppm had a greater effect (Fig. 4). EOs treatments and the interactions between EOs and Et did not show the significant effect on vase-life. Summer

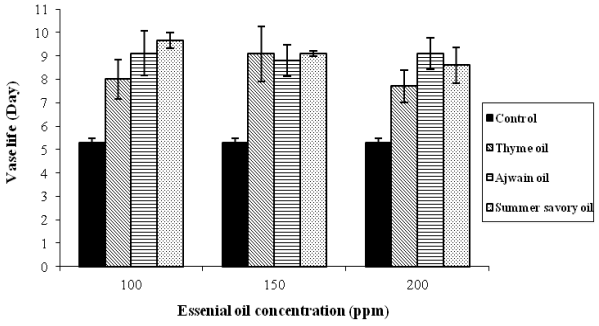

Fig. 3. Effect of different concentrations of Thyme, Ajwain and Summer savory essential oils on vase-life of carnation cut flowers (cv. 'Yellow Candy')

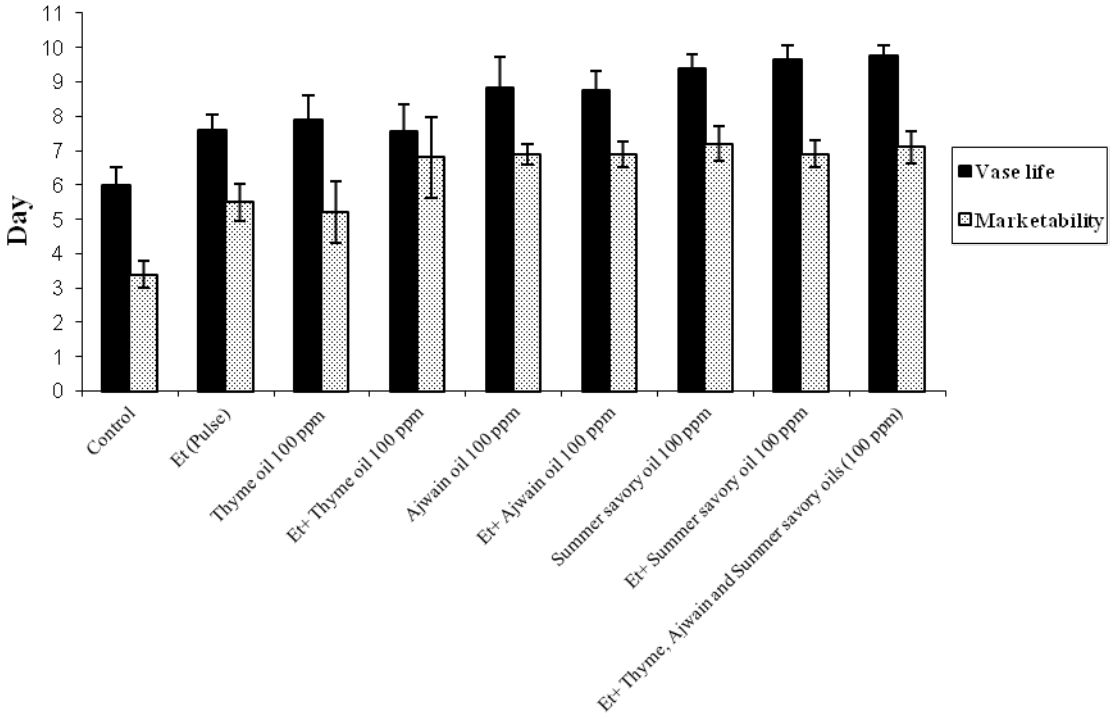

Fig. 4. Effect of pulse Et and different concentration of essential oils (100 ppm) alone and in combination treatment on vase-life and marketability of carnation cut flowers (cv. 'Yellow Candy')

savory oil treatments had stronger effect on vase-life extension than others. Marketability of carnation cut flowers increased in all treatments as compared to the control as well (Fig. 4).

Based on the present results, the fresh weight on the day of six after treatment showed there is no significant differences between control and the treated cut flowers with 4% Et (pulse), Thyme oil (100 ppm) and combination of these two treatments ($p \leq 0.01$). But other treatments compared to the control resulted in higher relative fresh weight, so that Summer savory oil (100 ppm) had the greatest effect (approximately twice as much as control) (Fig. 5). As shown in fig. 6 in the first 3-day after treatment the relative fresh weight of cut flowers treated with Thyme oil (100 ppm), Et and their combination treatment were lower than the starting point. In contrast, 100 ppm Summer savory oil, combination of Et with 100 ppm Summer savory oil and the combination resulted in higher fresh weight on 6^{th} day compared to the initial relative fresh weight. Among various essential oil treatments, Summer savory oil (100 ppm) had the strongest effect on increase in, and maintenance of fresh weight compared to initial value (Fig. 6).

According to the texts, ethylene, as senescence hormone reduces vase-life of cut flowers. Et increase vase-life by inhibiting ethylene synthesis and sensitivity to ethylene action. It also inhibits conversion of ACC into ethylene (Heins and Blakely, 1980; Wu *et al.*, 1992). Van Doorn *et al.* (1994) showed that carnation flowers are sensitive to high populations of bacteria in vase solution and presence of the bacteria causes vascular blockage, prevents water uptake and consequently results in reduction of fresh weight. Et as a disinfection and antimicrobial agent inhibits bacterial growth in the solution which leads the increase of flower vase-life (Van Doorn, 1998). Moreover, EOs have antimicrobial properties which reduce amount of bacteria in vessels and vase solution which helps Et disinfecting function. High value of relative fresh weight in treatments including EOs compared to control in 6^{th} day indicate higher rate of water uptake by flower and higher degree of freshness (Fig. 5). The above results are in accordance with Solgi *et al.* (2009). They reported that the ideal flower preservative is that allows water absorption through flower tissues. Water absorption from the preservative solution maintains a better water balance and flower freshness which saves from early wilting and reflecting on vase-life improve. Provide antibacterial agents that will keep the water free from bacteria and other microorganisms and can form occlusion inside the stem obstructing the flow of water to the flower (Van Doorn *et al.*, 1994).

EOs have strong antimicrobial properties against some pathogens and bacteria because of high levels of phenolic compounds such as carvacrol, thymol and eugenol. The improved vase-life by using EOs treated preservative solutions might be due to their role in inhibiting the microbial growth and preventing bacterial plugging. These results are in agreement with those of Saini *et al.* (1994) showed that the vase-life of tuberose cut flowers increased when placed in solutions with different concentrations of essential oils. Halevy and Mayak (1981) demonstrated that

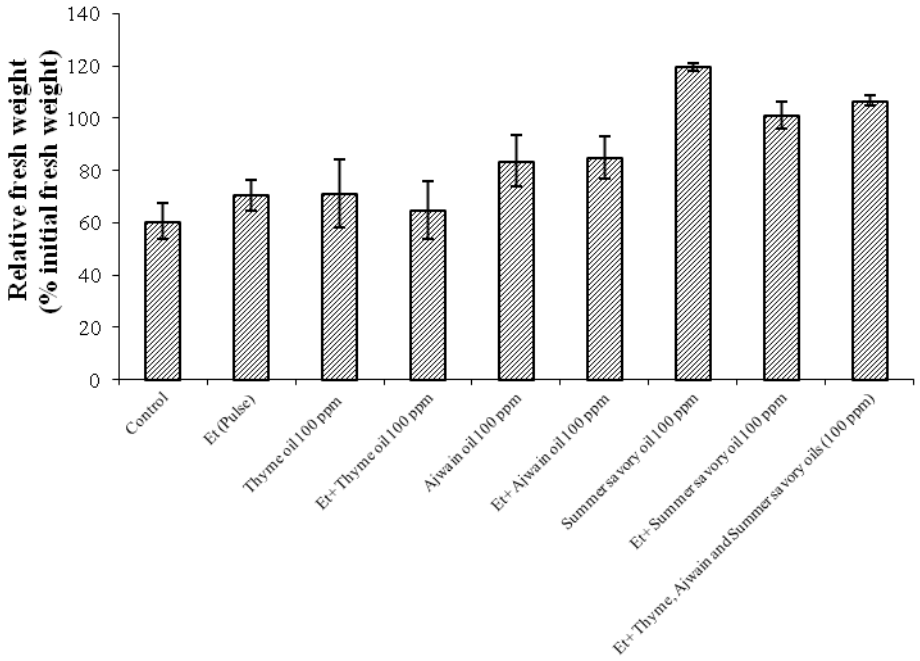

Fig. 5. Effect of pulse Et and 100 ppm concentration of different essential oils alone and in combination treatment on relative fresh weight of carnation cut flowers (cv. 'Yellow Candy')

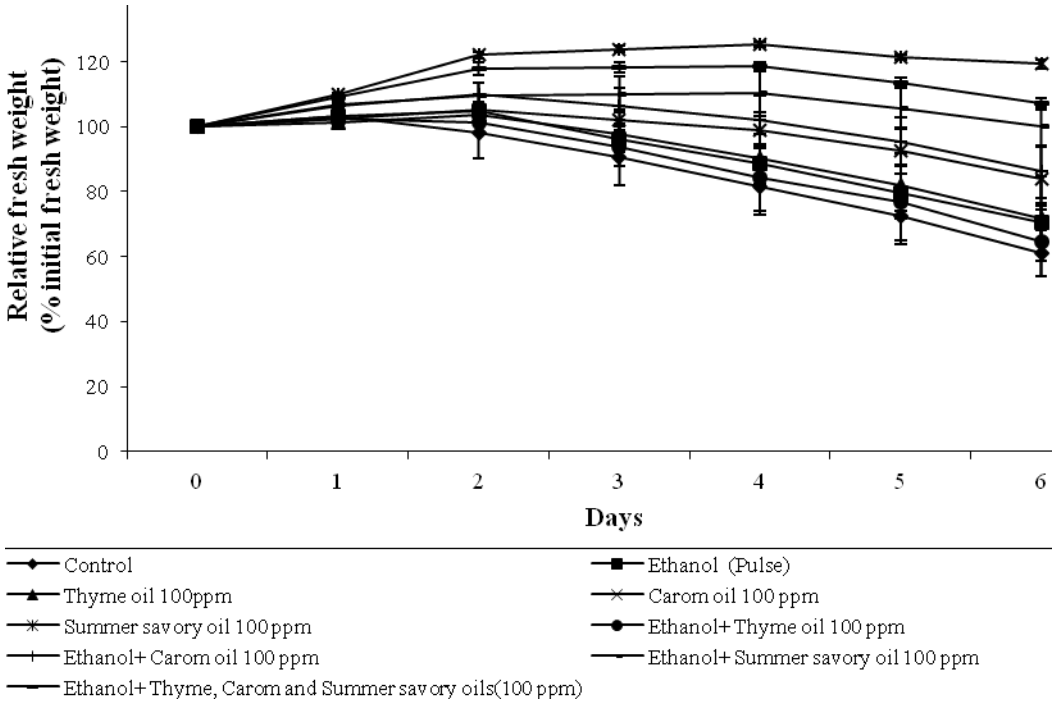

Fig. 6. Effect of pulse Et and 100 ppm concentration of different essential oils alone and in combination treatment on relative fresh weight during the first 6 day of the experiment (cv. 'Yellow Candy')

vase-life of rose, gypsophila, gerbera, carnation and chrysanthemum was improved significantly with germicide solution whereas increasing microbial contamination in the vase water resulted in poor vase-life in many cut flowers (Hoogerwerf and Van-Doorn, 1992). Oroojalian *et al.* (2010) showed that Ajwain oil had a strong antibacterial effect on some food borne pathogens. Reduction in membrane integrity, destruction of enzymatic systems involved in energy production and cellular structure components are the main mechanisms of these compounds in mitigating microbial infection (Sikkema *et al.*, 1995; Wilkins and Board, 1989).

Conclusions

Application of Et alone and in combination with different concentrations of EOs in preserving solution prolonged the vase-life of carnation cut flowers. But there is no significant differences between ET and EOs, as carnation cut flower vase-life as concerned. Based on the present results, EOs as safe and nature friendly compounds can be appropriate alternative compound in improving of vase-life of carnation cut flowers. Commercialization of these compounds needs further experiments about their formulation.

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