Journal of Medicinal Plants and By-products (2013) 2: 163-169

Original Article

Treatment with Essential Oils Extends the Vase Life of Cut Flowers of Lisianthus (*Eustoma grandiflorum*)

Hassan Bayat[1], Reza Geimadil[1*] and Ali Abdollahi Saadabad[2]

[1]*Department of Horticultural Science, Faculty of Agriculture, Ferdowsi University of Mashhad, PO Box 91775-1163 Mashhad, Iran*
[2]*Department of Horticultural Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran*

Article History: Received: 12 July 2013/Accepted in revised form: 22 December 2013

Abstract

Lisianthus (*Eustoma grandiflorum* cv. 'Mriachii Blue') is one of the most important and marketable cut flowers in the world. However, a relatively limited vase life reduces its marketability. The aim of the present study was to evaluate the effects of essential oils in extending vase life of cut flowers of Lisianthus. For this purpose a factorial experiment based on a completely randomized design with *Zataria multiflora* and *Echinophora platyloba* essential oils at (0, 100, 200 ppm) with 3 replications, was conducted. The results showed that addition of essential oils to vase solutions increased vase life, petal water content, leaf relative water content and SPAD value, significantly. The highest vase life (14.5 days) was observed in the vase solution containing 200 ppm *E. platyloba* plus 100 ppm *Z. multiflora* essential oils with 95% increase as compared to the control. All essential oil treatments resulted in higher relative fresh weight as compared to the control; however the highest relative fresh weight was observed in cut flowers treated with *E. platyloba* essential oil at 200 ppm with 54% increase over the control. It can be safely concluded that essential oils as natural, safe and biodegradable compounds are suitable alternatives to conventional chemical treatments in order to prolong vase life of cut flowers of Lisianthus.

Key words: Essential oils, Medicinal plants, Postharvest, Relative fresh weight, Vase life, Lisianthus

Introduction

Lisianthus (*Eustoma grandiflorum*) (Raff.) Shinn. native to the Prairie States of North America, is now an important commercial cut flower [1]. Lisianthus has become very popular as a cut flower, because of the range of colors available, and the fact that each inflorescence comprises a long, straight stem bearing as many as 10 individual flowers [2]. The Lisianthus inflorescence has several opened flowers and buds. Thus, the longevity of each flower and the rate of bud opening are important factors in extending the vase life of the inflorescence. In addition, there are cultivar variations in the vase life of flowers [3].

Short postharvest vase life is one of the most important problems with the cut flowers. However, the longevity of vase life is an important factor in consumer preference [4,5]. The postharvest life of cut flowers is often limited by the accumulation of microorganisms in hydration solutions and flower stems which cause vascular blockage and thus reduce the vase life of cut flowers [6-8]. The addition of chemical preservatives to the holding solution is recommended to prolong the vase life of cut flowers. In general, treatments such as ethylene inhibitors, sugars and antimicrobial compounds applied by growers are also important to ensure a long vase life of flowers for consumers. There are some researches that have been applied different

*Corresponding author: Department of Horticultural Science, Faculty of Agriculture, Ferdowsi University of Mashhad, PO Box 91775-1163 Mashhad, Iran.
E-mail Address: r.geimadil@gmail.com

chemicals to extend vase life of Lisianthus [9-13], but a new worldwide trend is to explore natural alternatives that control postharvest diseases, giving priority to current decay-preventing methods with a minimal effect on human health and the environment [14].

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 [15,16].

Zataria multiflora (Avishan-e-Shirazi in Persian) is an endemic thyme-like plant and a member of Labiatae family that grows wild in central and southern Iran [17]. In general, EOs of *Z. multiflora* was found to contain 26 types of different substances such as thymol (48.4 percent) and carvacrol (12.6 percent) which are antimicrobial and antifungal agents [18]. *Echinophora platyloba* is another Iranian endemic plant species, which also has antimicrobial and antifungal prosperities, grows in different part of central and western provinces of Iran [19].

EO has been recently used to control pathogens of fruits, vegetable and food [20-22]. It has also been reported that EOs are used in preserving solution for extending the vase life of Gerbera [23] and carnation [24] cut flowers. There is no information on the effect of EOs on the vase-life of Lisianthus cut flowers. Therefore, the aim of this study was to evaluate the effects of *Z. multiflora* and *E. platyloba* EOs on vase life of cut lisianthus flowers.

Materials and Methods

Plant material

Lisianthus (*Eustoma grandiflorum* cv. 'Mriachii Blue') flowers were obtained from a standard hydroponic greenhouse in Mashhad (36° 17' 44" N and 59° 36' 42" E), Iran. Plants were grown under standard greenhouse conditions with 22 and 16 °C day and night temperatures, respectively. The flowers were harvested at half-open stage [10] at 7 am and immediately transferred to the laboratory in plastic packages. The stems were trimmed to 30 cm and placed in the glass vials containing 300 ml of the test solutions.

Treatments and Experiment Design

Standard *Z. multiflora* and *E. platyloba* EOs were obtained from Barij Essence Pharmaceutical Company (Kashan, Iran). EOs were diluted in 0.01% dimethyl sulfoxide [DMSO] (Merck Co., Darmstadt, Germany). The experiment was conducted as a factorial experiment based on a completely randomized design with combination of *Z. multifora* Bioss. and *E. platyloba* L. essential oils at (0, 100, 200, 300 ppm) with 3 replicates and 3 samples (individual flowers) for each replication. The experiment was carried out at 21±1 °C and 60% RH under continuous fluorescent light (47 μ mol m^{-2} s^{-1}).

Measurements and data collection

The end of vase life was defined as the time that flowers showed symptoms of wilting, loss and discoloration of the petals. Leaf greenness or chlorophyll reading values (measured as the optical density, SPAD reading) were recorded on day 8 of the experiment on three leaves per plant at similar middle positions on the stems of all plants in each treatment using a portable SPAD chlorophyll meter (SPAD 502, Minolta, Japan).

Leaf relative water content (RWC) from each sample was determined on day 8 according to the method described by [25] and was calculated using the equation below:

% RWC= (FW-DW)/ (TW-DW) × 100

In the next stage and on the 8th day from the start of the experiment, 1g of petals from all replications and each sample was taken as FW and then dried at 70 °C for 24 h and the DW was recorded. Petal water content (%WP) was then determined with the below equation [26]:

%WP= FW-DW/DW × 100

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

R.F.W. (%) = (W_t/W_0) ×100

W_t represents the fresh weight in the first six days of experiment and W_0 is initial fresh weight in the beginning of the experiment.

Statistical analysis

Statistical analysis between mean values was assessed using analysis of variance (ANOVA) and LSD Test at $p \leq 0.05$ using JMP8 statistical software.

Results and Discussion

According to the results shown in Table 1, using EOs as preservatives significantly increased the vase life of lisianthus cut flowers, over control.

Table 1 Effects of different concentrations of *Z. multiflora* and *E. platyloba* essential oils on vase life, WP, RWC and SPAD value of cut Lisianthus flowers (cv. 'Mriachii Blue')

Treatment	Vase life (day)	WP [a] (%)	RWC [b] (%)	SPAD value
E. platyloba oil (ppm)				
0	8.7 c	49.5 b	29.4 c	46.4 c
100	13.8 b	63.4 a	32.9 b	50.6 b
200	14.9 a	61.9 a	46.3 a	52.8 a
Z. multiflora oil (ppm)				
0	10.9 c	56.8 b	35.1 b	45.1 b
100	12.2 b	57.1 b	42.4 a	50.2 ab
200	14.4 a	61. a	36.2 b	50.6 a
E. platyloba oil	**	**	**	**
Z. multiflora oil	**	**	**	**
E. platyloba oil × *Z. multiflora* oil	*	**	**	**

*, ** indicate significance at $P < 0.05$ and 0.01 probabilities, respectively
[a] Petal water content (%) and [b] Leaf relative water content

E.platyloba and *Z. multiflora* EOs (200 ppm) increased the vase life by 71 and 32 percent as compared to control (Table 1). The highest and lowest vase lives (14.5 and 7.4 days) were observed in solutions containing 200 ppm *E. platyloba* plus 100 ppm *Z. multiflora* EOs and the control, respectively (Fig. 1). It has also been reported that EOs extended the vase life of tuberose [27], Gerbera [23], Gladiolus [28] and carnation [24] cut flowers which is in concurrence with the present results.

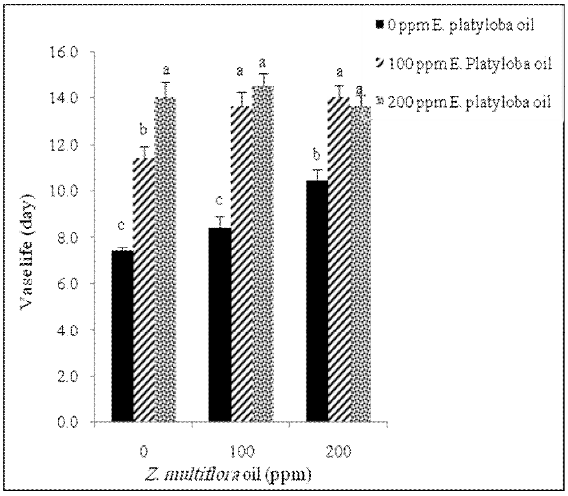

Fig. 1 Interaction effects of *E. platyloba* and *Z. multiflora* essential oils on extending the vase life of cut Lisianthus flowers. Bars indicate ± standard error.

The results showed that the addition of EOs to vase solutions significantly increased petal water content (WP) of lisianthus cut flowers (Table 1). Effects of (Table 1). Interaction effects showed that the highest amount (41.08%) of petal water content was obtained at 200 ppm *E. platyloba* (66.5%) (Fig. 2).

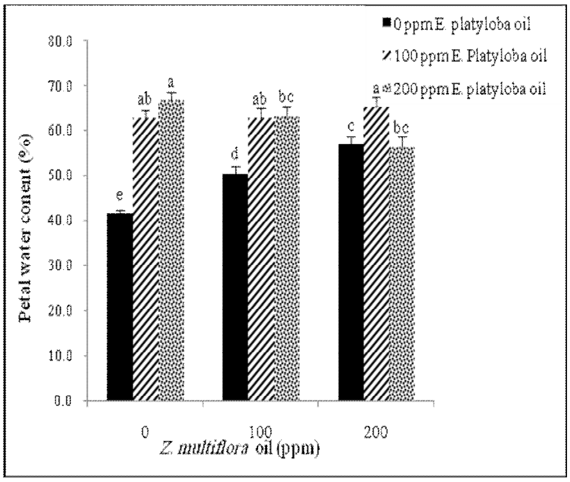

Fig. 2 Interaction effects of *E. platyloba* and *Z. multiflora* essential oils on petal water content of cut Lisianthus flowers. Bars indicate ± standard error.

Effects of *E. platyloba* and *Z. multiflora* EOs were highly significant on leaf relative water contents (RWC) and the highest values were observed at 200 ppm *E. platyloba* (46.3%) and 100 ppm *Z. multiflora* (42.4%) EOs (Table 1). Among interaction treatments, the treatment 100 ppm *Z. multiflora* plus 200 ppm *E. platyloba* EOs increased RWC 1.2 fold in comparison to control (Fig. 3) . According to the present results, the addition of EOs to vase solutions increased the chlorophyll reading values (SPAD) of Lisianthus cut flowers (Table 1). With *E. platyloba* and *Z. multiflora* EOs, SPAD value increased by 13 and 12 percent as compared to control (Table 1). Interaction effects showed that the highest SPAD value (55.8%) was obtained at 200 ppm *E. platyloba* oil (Fig. 4).

Based on the present results, the fresh weight on the day of six after treatment showed significant differences between control and the treated cut flowers with EO treatments.

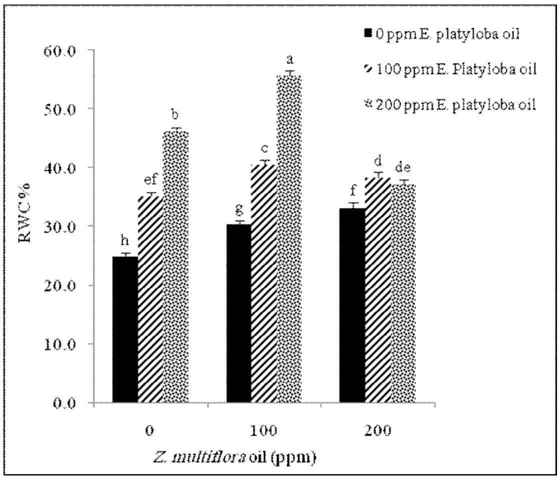

Fig. 3 Interaction effects of *E. platyloba* and *Z. multiflora* essential oils on leaf relative water contents (RWC) of cut Lisianthus flowers. Bars indicate ± standard error.

All EO treatments resulted in higher relative fresh weight as compared to the control; however the highest relative fresh weight was observed in the vase solution containing 200 ppm *E. platyloba* oil with 54% increase over the control (Fig. 5). As shown in Fig. 6 in the first 3-day after treatment the relative fresh weight of cut flowers treated with control and *Z. multiflora* oil (100 ppm) was lower than the starting point.

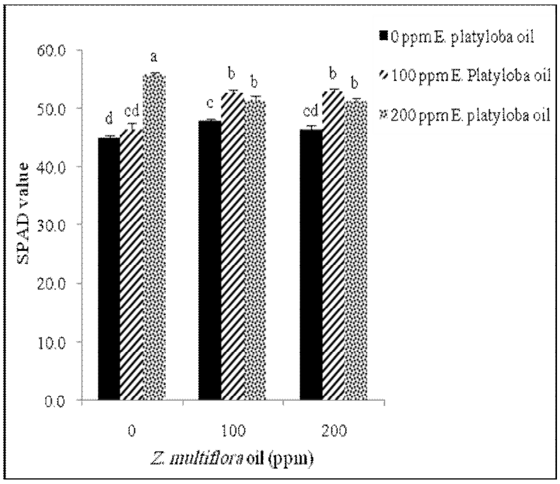

Fig. 4 Interaction effects of *E. platyloba* and *Z. multiflora* essential oils on SPAD value of cut Lisianthus flowers. Bars indicate ± standard error.

One of the most important issues in postharvest flower physiology is the blockage of the vascular system, due to bacterial growth, which reduces water uptake [29]. De La Riva *et al.* [30] showed that cut Lisianthus flowers are sensitive to high populations of bacteria in vase solution and the presence of the bacteria causes vascular blockage, prevents water uptake and consequently results in reduction of fresh weight.

It has been suggested that use of antimicrobial compounds improves water conductance by preventing bacterial growth and producing occlusions [31].

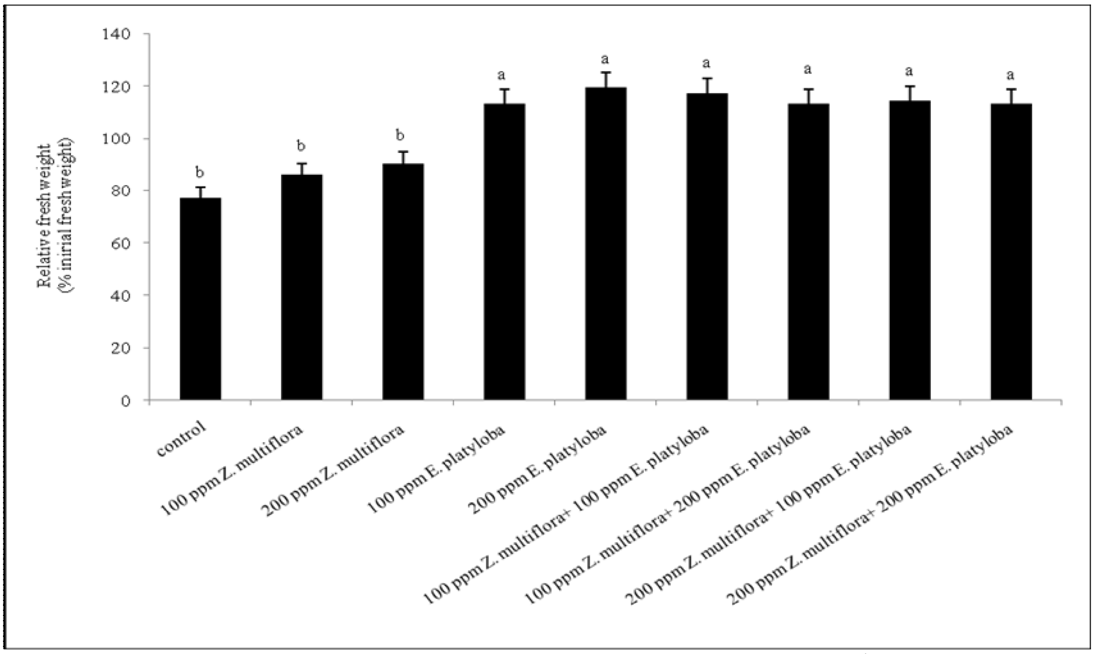

Fig. 5 Effects of *E. platyloba* and *Z. multiflora* essential oils on relative fresh weight in 6^{th} day of the experiment (cv. 'Mriachii Blue'). Bars indicate ± standard error.

EOs have strong antimicrobial properties against some pathogens and bacteria because of high levels of phenolic compounds such as carvacrol, thymol and eugenol. The improvement in vase life in preservative solutions containing these components might be due to their role in inhibiting the microbial growth and preventing bacterial plugging of water conducting tissues. Saini *et al.* [27] mentioned that the vase life of tuberose cut flowers increased when placed in some chemical preservative solutions. Halevy and Mayak [32] reported that vase life of roses, Gypsophila, Gerbera, carnation and Chrysanthemum was improved significantly with germicide solution. Alternatively, increasing the number of microorganisms in the vase water resulted in poor vase life in many cut flowers [33]. Higher values of relative fresh weight in treatments including EOs compared to control in 6^{th} day indicate a higher rate of water uptake by the flower and higher degree of freshness (Fig. 4). The above results are in accordance with Solgi *et al* [23] who reported that an ideal flower preservative allows water absorption through flower tissues. Water absorption from the preservative solution maintains a better water balance and flower freshness which saves it from early wilting and improving vase life. Besides, antibacterial agents will keep the water free from bacteria and other microorganisms and form occlusion inside the stem obstructing water flow to the flower [6,9]. Moreover, the higher measured RWC, the greater ability of the treatment for keeping water [34].

Thus, according to the present results, it seems that at day 8 of the experiment, samples placed in control treatments were under severe stress and could not take up and keep the water properly, whereas comparatively EO treatments were in normal conditions. Reduction in membrane integrity, destruction of enzymatic systems involved in energy production and cellular structure components are the main mechanisms of EOs in mitigating microbial infection [35,36].

The present results showed that application of different concentrations of EOs in preserving solutions prolonged the vase life of cut Lisianthus flowers.

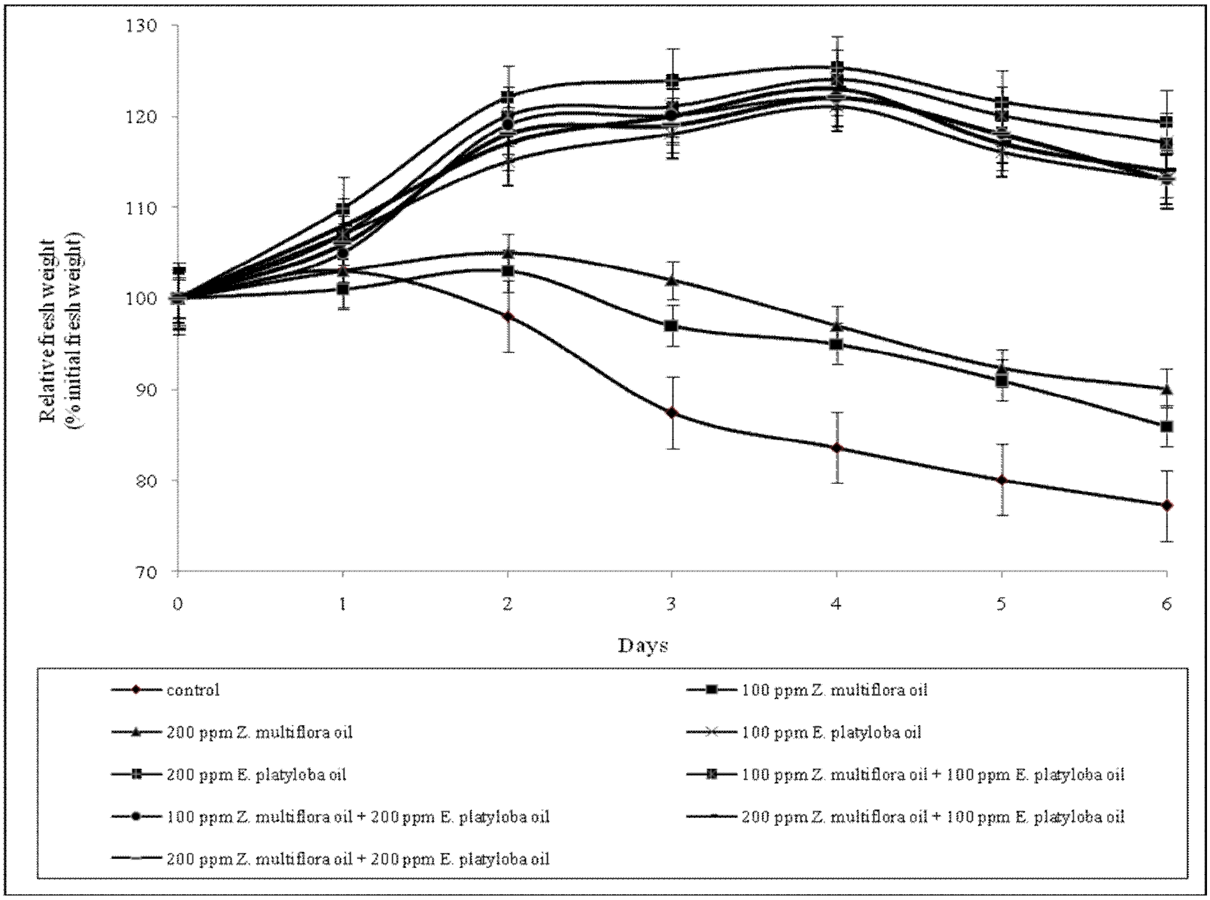

Fig. 6 Effects of *E. platyloba* and *Z. multiflora* essential oils on relative fresh weight during the first 6 days of the experiment (cv. 'Mriachii Blue'). Bars indicate ± standard error.

The highest vase life was observed in the vase solution containing 200 ppm *E. platyloba* plus 100 ppm *Z. multiflora* essential oils with 95% increase as compared to the control. EOs as safe and nature friendly compounds can be appropriate alternatives to extend the vase life of cut lisianthus flowers. Commercialization of these compounds needs further experiments about their formulation.

References

1. Halevy AH, Kofranek AM. Evaluation of lisianthus as a new flower crop. HortScience. 1984;19:845-847.
2. Tjia B, Sheehan TJ. Chemical height control of *Lisianthus russellianus*. HortScience. 1986;21:47-148.
3. Shimizu-Yumoto H, Ichimura K. Cultivar variation in the vase life of unpollinated Eustoma flowers associated with ethylene. Hortic Res. (Japan) 8 (in Japanese with English summary). 2009;359-364.
4. Kader AA. A perspective on postharvest horticulture (1978-2003). Hortic Sci. 2003;38:1004-1008.
5. Da Silva JAT. The cut flower: postharvest considerations. Biol Sci. 2003;3:406-42
6. Van Doorn WG, Zagory D, Witte YD, Harkema, H. Effect of vase-water bacteria on the senescence of cut carnation flowers. Postharvest Biol Technol. 1994;1:161-168.
7. Zencirkiran M. Effect of sucrose and silver thiosulphate pulsing on stem-base cracking and vase life in *Leucojum aestivum* L. flowers. J Hortic Sci Biotech. 2005;80:332-334.
8. Zencirkiran M. Effect of 1-MCP (1- Methyl Cyclopropene) and STS (Silver thiosulphate) on the vase life of cut freesia flowers. Sci Res. Essays. 2010;5:2409-2412
9. Ichimura K, Shimamura M, Hisamatsu T. Role of ethylene in senescence of cut Eustoma flowers. Postharvest Biol. Technol. 1998;14:193-198.
10. Cho MS, Celikel FL, Reid MS. Sucrose enhances the postharvest quality of cut flowers of *Eustoma grandiflorum* (Raf.) Shinn. Acta Hortic. 2001;543:305-315.
11. Huang KL, Chen WS. BA and sucrose increase vase life of cut Eustoma flowers. HortSci. 2002;37:547-549.
12. Shimizu H, Ichimura, K.Effects of silver thiosulfate complex (STS), sucrose and their combination on the quality and vase life of cut Eustoma flowers. J. Jpn. Soc. Hortic Sci. 2005; 74:381-385.
13. Meir S, Salim S, Cherov Z. Philosoph-Hadas, S. Quality improvement of cut flowers and potted plants with postharvest treatments based on various cytokinins and auxins. Acta Hortic. 2007;755:143-154.
14. Bautista-Banos S, Hernandez-Lauzardo AN, Velázquez-del Valle MG, Hernandez-Lopez M, Ait-Barka E, Bosquez-Molina E, Wilson CL. Chitosan as a potential natural compound to control pre and postharvest diseases of horticultural commodities. Crop Prot. 2006;25:108-118.
15. Lambert RJW, Skandamis PN, Coote PJ, Nychas GJE. A study of the minimum inhibitory concentration and mode of action of oregano essential oil, thymol and carvacrol.. J Appl Microbiol. 2001;91:453-462.
16. Mihajilov-krstev T, Radnovic D, Kitic D. Stojanovic-Radic, Z., Zlatkovic, B. Antimicrobial activity of *Satureja hortensis* L. essential oil against pathogenic microbial strains. Arch Biol Sci. 2010;62:159-166.
17. Amin GH. Popular Medicinal Plants of Iran. Deputy Minister of Research Publication, Ministry of Health, Treatment and Medical Education, Tehran. 1991.
18. Shafiee A, Javidnia K. Composition of essential oil of *Zataria multiflora*. Planta Medica 1997;63:371-372.
19. Mozaffarian V. A Dictionary of Iranian Plant Names. Farhang Moaser Publishers, Tehran, 1996; pp:260-261.
20. Thunberg RL, Tran TT, Bennett RW, Matthews RN, Belay N. Microbial evaluation of selected fresh produce obtained at retail markets. J Food Prot. 2002;65:677-682.
21. Burt S. Essential oils: their antibacterial properties and potential applications in food: a review Int. J Food Microbiol. 2004;94:223-253.
22. Valero M, France´s E. Synergistic bactericidal effect of carvacrol, cinnamaldehyde or thymol and refrigeration to inhibit *Bacillus cereus* in carrot broth. J Food Microbiol. 2006;23:68-73.
23. Solgi M, Kafi M, Taghavi TS, Naderi R. Essential oils and silver nanoparticles (SNP) as novel agents to extend vase-life of gerbera (*Gerbera jamesonii* cv. 'Dune') flowers. Postharvest Biol Technol. 2009;53:155-158.
24. Bayat H, Azizi M, Shoor M, Mardani H. Effect of ethanol and essential oils on extending vase life of carnation cut flower (*Dianthus caryophyllus* cv. 'Yellow Candy'). Not Sci Biol. 2011;3:100-104.
25. Henson IE, Mahalakshmi V, Bidinger FR, Alagars–Wamy G. Genotypic variation in pearl miller (*Pennisetum americanum* L.) Leeke in the ability to accumulate abscisic acid in response on water stress. J Exp Bot. 1981;32:899-910.
26. Kalate Jari S, Khalighi A, Moradi F. Fatahi moghadam MR. The Effect of Calcium Chloride and Calcium Nitrate on Quality and Vase Life of Rose Flowers cv. Red Giant. Olum Fonun Iran. 2008;9:163-179.
27. Saini RS, Yamdaqni R, Sharma SK, Effect of some chemicals on keeping quality and vase life of tuberose (*Polianthes tuberosa* L.) cut flowers. Pak. J Soc Sci. 1994;42:376-378.
28. Hegazi MA, Gan E. Influences of some essential oils on vase life of *gladiolus hybrida*, l. spikes. Int. J Agro Vet Med Sci. 2009;3:19-24.
29. Loubaud M, Van Doorn WG. Wound-induced and bacteria-induced xylem blockage in roses, Astilbe, and Viburnum. Postharvest Biol Technol. 2004;32:281-288.
30. De La Riva F, Mazuela PC, Alvaro JE, Urrestarazu M. Treatment with Peracetic acid extends the vase life of lisianthus (*Eustoma grandiflorum*) flowers.. HortScience. 2009;44,:418-420.

31. Van Doorn WG. Effects of daffodil flowers on the water relations and vase life of roses and tulips. J Am Soc Hortic Sci. 1998;123:146–9.
32. Halevy AH, Mayak S. Senescence and postharvest physiology of cut flowers, Part 2. Hortic Rev. 1981;3:59-143.
33. Hoogerwerf A, Van Doorn WG. Numbers of bacteria in aqueous solutions used for postharvest handling of cut flowers. Postharvest Biol Technol. 1992;1:295-304.
34. Abbaszadeh B, Sharifi Ashourabadi E, Lebaschi MH, Hajibagher MN, Moghadami F. The effect of drought stress on proline, soluble sugars, chlorophyll and relative water contents of balm (*Melissa officinalis* L.). Iran J Pharm Res. 2008;23:504-513.
35. Wilkins KM, Board RG. Natural antimicrobial systems. In: Gould, G.W.(ed.) Mechanisms of Action of Food Preservation Procedures., London, Elsevier, 1989. pp 285.
36. Sikkema J, Bont AM, Poolman B. Microbiological Reviews, 1995;59:201-222