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Study on Interaction Effects of Mechanical and *Geranium* Essential Oil Treatments on Vase Life of Cut *Chrysanthemum* (*Dendranthema grandiflorum* L.)

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Abstract

The aim of this study is investigation on effect of stem end splitting and *Geranium* essential oil on vase life on quality of cut chrysanthemum (*Dendranthema grandiflorum* L.). This experiment arranged as factorial based on RCD with 2 factors of stem end splitting at 2 levels (with splitting and without splitting) and *Geranium* essential oil at 6 levels (0, 1, 2, 4, 8 and 10 %), with 12 treatments, 3 replications, 36 plots and 144 cut flowers. In this experiment traits such as vase life, water absorption, fresh weight, dry matter percent and °brix were measured. ANOVA showed that different among treatments was significant for vase life, °brix and fresh weight in 1% probability and for dry matter percent and water absorption in 5% probability. Results showed that different treatments improved vase life compared to control and maximum vase life was achieved in 5 cm splitting + 10% *Geranium* essential oil with 18.41 days compared to control (7.05 days).

Keywords: *Chrysanthemum, Geranium* essential oil, Stem end splitting, Vase life.

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflorum* L.) belongs to the Asteraceae family. This is a native plant of China and cultivated for thousands of years. Todays, new varieties of this plant were breeded for using as cut flowers, potted plants and garden plants and has a high economic value in the global market (Kandil *et al.*, 2011). Chrysanthemum is a non-climactric flower with a long vase life and its long vase life is also due to non sensitivity to ethylene. However, the formation of air embolism in the vascular of stem that prevents water transport in stem and leads to close the vascular tubes which ultimately leads to increase hydraulic resistance in the stem and water stress, and reduces the vase life of chrysanthemum (Halvey and Mayak, 1981; Van Leperen *et al*., 2001).

Bactericidal compounds such as essential oils and plant extracts were used as environmentally friendly compounds and as new factors that affect postharvest life of cut flowers (Solgi *et al.*, 2009). The use of herbal essences in the preservative solution for cut flowers is relatively new and the positive effect of these compounds have been reported (Solgi *et al.*, 2009; Diy, 2008; Mousavi Bazaz and Tehranifar, 2011).

Geranium is a flowering plant and is also valuable because of having ingredients or secondary metabolites. Parts of the plant used for preparing essence are the leaves and air parts. Aromatic geranium essence is similar to the rose flower and its main compound include geraniol, citronellol, terpineol and alcohols (Mithila *et al*., 2011). Solgi *et al.* (2009) stated that the use of essential oils of garden thyme and Shiraz thyme, and their active ingredients increased vase life of cut flowers. The purpose of this study was to evaluate the effect of aromatic geranium extract and 5 cm split on postharvest life and durability of chrysanthemum cut flower and introduce the best treatments.

MATERIALS AND METHODS

In October 2014, chrysanthemum cut flowers harvested at commercial stage from a greenhouse in Isfahan and immediately were transferred to post-harvest laboratory. This study was performed in factorial experiment based on RCD with 2 factors, the split of 5 cm of stem end and without split and the second factor of aromatic geranium extract in 6 levels (0, 1, 2, 4, 8 and 10%) with 12 treatments, 3 replications, 36 plots and 4 flowers in each plot. Vase life room was with 12 h photoperiod, light intensity of 12 µmol s^{-1} m^{-2}, relative humidity of 60 to 70% and the temperature of 20 ± 2° C.

Vase life was defined as the time from the start of treatment until the senescence of flowers. Regarding the final weight of flower in the last day, recut weight, weight of losses and weight of the first day, the increase of fresh weight was calculated according to the following equation:

Fresh weight increasing = (weight of losses + weight of recut+ final weight at last day of the control life) - initial weight

Considering initial volume of vase solution (500 mL) and rate of evaporation in room and reduction of volume of vase solution, water absorption was calculated by using following equation:

Water absorption (ml g^{-1} FW) = 500 - (mean evaporation of room + remained solution at the end of vase life) ÷ the average of fresh weight cut flowers

After ending the vase life of the control, fresh weight of each flower was measured and at the end of the vase life, it was placed at 70 ° C for 24 hours. After ensuring complete drying of flowers, they were weighted by a digital scale. Dry matter percent was calculated from the following equation:

Dry matter percent = (dry weight ÷ fresh weight of flowers at the last day of the control vase life) × 100

°Brix was measured manually in 2 stages by a refrectometer, N-1α model, manufactured by ATAGO Company, Japan and the increase of °Brix was calculated by the following formula:

The increase of °Brix = °Brix of the last day - °Brix of the first day

Data analysis was performed using SAS software and comparision was performed according to LSD test.

RESULTS AND DISCUSSION

Vase life

Analysis of variance showed that the effects of aromatic geranium extract, split and the interaction of them are statistically significant at the 1% level (Table 1). The results of the comparison showed that all treatments increased vase life compared with the control. So that the control with 8.06 days had the minimum vase life and the split along with 10% aromatic geranium extract with 18.41 days had the maximum vase life among treatments (Fig. 1).

The use of antimicrobial compounds along with stem end split caused a significant improvement in the life of chrysanthemum cut flowers compared with the control.

Since the vase life is directly related to water absorption, it can be said that germicidal composition with the split used in *Alstroemeria* cut flowers increases water absorption through exposing wide surface of stem with vase life solution and reduces microbial loads of vase solution and thus helps maintaining freshness and durability of this cut flower by the continuation of water absorption (Mehri, 2014). Solgi *et al*. (2009) studied on cut gerbera flowers and reported that the use of herbal essences as a disinfectant and environmentally-friendly compound significantly increases with the postharvest life of this cut flowers. Mousavi Bazaz and Tehrainfar (2011) also found similar results regarding the positive effect of essences of cumin, mint and thyme on durability of *Alstroemeria* cut flowers. The researchers stated that treatment with 50 mg l^{-1} of thyme essence improves the vase life of *Alstroemeria* for 2 days compared with the control.

Table 1. ANOVA of effects of mechanical and *Geranium* essential oil treatments on traits.

Source	df	Vase life	Dry matter percent	°Brix	Fresh weight	Water absorption
Oil (O)	5	15.043**	33.51*	4.88**	53.61**	1.328*
Splitting (S)	1	91.52**	38.19*	1.416**	156**	28.81**
O*S	5	14.62**	34.84*	0.795**	58.39**	2.492*
Error	24	1.913	6.33	0.173	6.95	0.497
cv (%)	-	9.31	8.57	23.81	20.73	17.29

**: Probability 1% *: Probability 5%

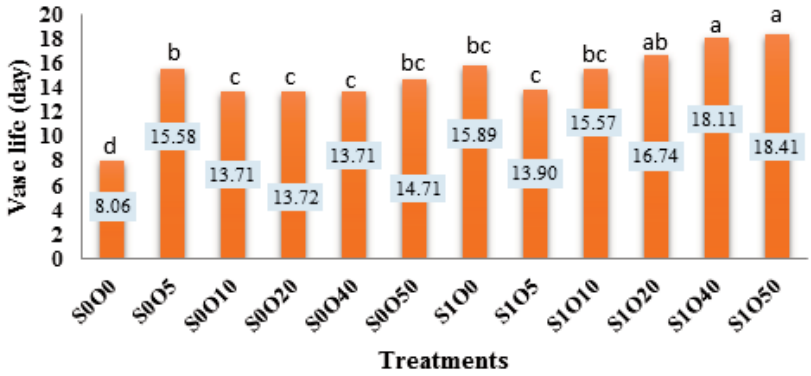

Fig. 1. Effects of mechanical and *Geranium* essential oil treatments on vase life.

S0= Without splitting S1= With 5^{cm}splittimg
O0= No *Geranium* essential oil O20= *Geranium* essential oil 4%
O5= *Geranium* essential oil 1% O40= *Geranium* essential oil 8%
O10= *Geranium* essential oil 2% O50= *Geranium* essential oil 10%

Water absorption

Analysis of variance of data showed that geranium extract and interaction of them are statistically significant at the 1% level but splitting was significant at 5% probability (Table 1). Mean Comparison of these two factors showed that 5 cm splitting + 10% geranium extract with 5.743 ml g^{-1} FW and the control with 2.320 ml g^{-1} FW had the highest and the lowest water absorption, respectively (Fig. 2).

Inability to water absorption is the main cause of aging of cut flowers and reducing the longevity of them. This is often done by closing the vessels. The use of antimicrobial compound in vase solution by preventing the growth and performance of microbes, protects xylem from obstruction and thus water absorption occurs without interruption and consequently the freshness of the flowers is maintained (Kim and Lee, 2002; Shanan, 2012; Anjum *et al.,* 2001). In this study, all of the antimicrobial treatments and 5 cm split increased water absorption compared with the control. Anjum *et al*. (2001) reported that the addition of antimicrobial compounds in vase solution life prevents microbe growth and increases water absorption by the cut flower. El-Hanafi (2007) argued that the use of antimicrobial compounds such as herbal essence in vase solution, by reducing the solution's pH, causes balancing and water absorption by the stem of cut carnation. Shanan (2012) reported that herbal essences by preventing the vascular occlusion improves the absorption of water in rose cut flowers that the results of this study is in agreement with the current study. Nabigol *et al*. (2006) found that antibacterial, anti-ethylene and antibiotics compounds significantly increase water absorption in chrysanthemum cut flowers.

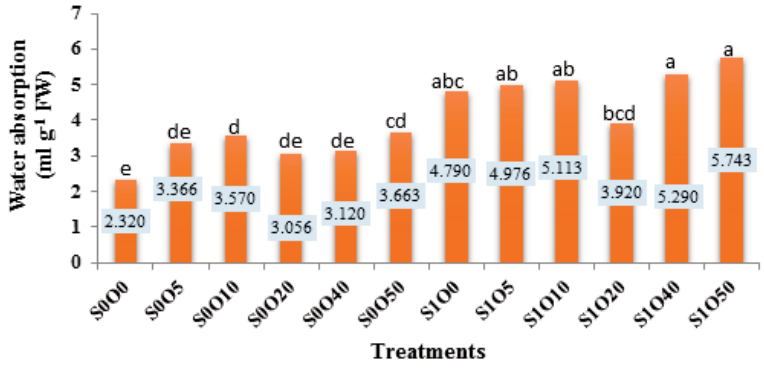

Fig. 2. Effects of mechanical and *Geranium* essential oil treatments on water absorption.

S0= Without splitting S1= With 5cmsplittimg
O0= No *Geranium* essential oil O20= *Geranium* essential oil 4%
O5= *Geranium* essential oil 1% O40= *Geranium* essential oil 8%
O10= *Geranium* essential oil 2% O50= *Geranium* essential oil 10%

Fresh weight

Analysis of variance of data showed that geranium extract, splitting and interaction of them are statistically significant at the 1% level (Table 1). Results showed that all treatments in this experiment increased fresh weight compared to control and maximum increase is related to the split treatment and geranium extract of 8% with 20.06 g and the minimum is related to the control treatment with 5.60 g (Fig. 3).

Several studies have shown that the use of antimicrobial compounds in vase solution of cut flowers by reducing the microbial load and preventing the obstruction of the vessels increases water absorption and finally increases the fresh weight and freshness of cut flowers and thus increases the durability and good marketing of flowers. In this study, the use of antimicrobial com-

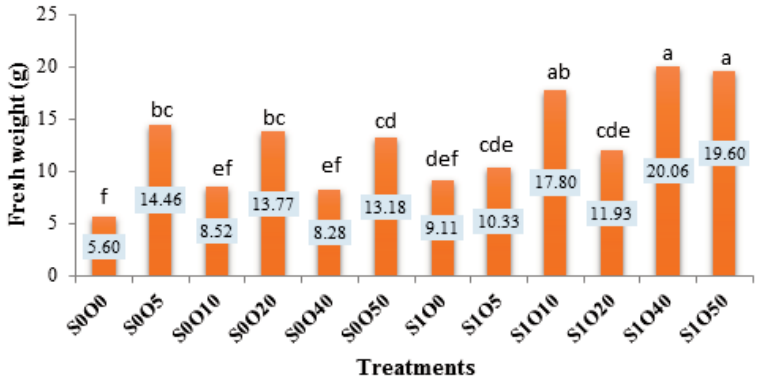

Fig. 3. Effects of mechanical and *Geranium* essential oil treatments on fresh weight.

S0= Without splitting S1= With 5cm splittimg
O0= No *Geranium* essential oil O20= *Geranium* essential oil 4%
O5= *Geranium* essential oil 1% O40= *Geranium* essential oil 8%
O10= *Geranium* essential oil 2% O50= *Geranium* essential oil 10%

pounds by increasing water absorption caused increasing the fresh weight compared with the controls. Jalili Marandi *et al*. (2011) reported that the Carum copticum essence at 500 mg l^{-1} increases the fresh weight by 1.8 g compared with the control.

Increasing °Brix

Analysis of variance showed that effect of geranium extract, effect of splitting and interaction of them are statistically significant at the 1% level (Table 1). Mean comparison showed that the maximum increase in °Brix is associated with the split treatment and geranium extract of 10% with 3.886% and the minimum one is related to the control treatment with 0.586% (Fig. 4).

The most important factor in delaying senescence of cut flowers is the increase in the amount of carbohydrates in the flower. Sugar (TSS) is one of the most important factors of determining the life of cut flowers. Therefore, carbohydrate increases the vase life (Mutui *et al*., 2011). Researchers believe that the recutting the cut flower stems under water and the efficacy of antimicrobial compounds on reducing the microbial load and enhancing the solution absorption causes maintaining and increasing carbohydrates in the stem of cut flowers (Basiri *et al.*, 2011; Bartoli *et al.*, 1997). Elgimabi and Ahmad (2009) reported that the antimicrobial compounds increase the amount of carbohydrates in the stem of rose cut flowers. Sugars had an important osmotic potential that by entering into the vacuole of the petals cells reduce cell osmotic potential and delay aging by increasing respiration (Edrisi, 2009).

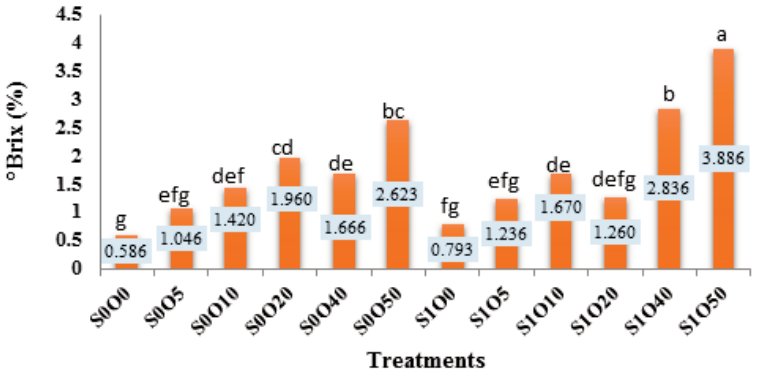

Fig. 4. Effects of mechanical and *Geranium* essential oil treatments on °Brix.

S0= Without splitting S1= With 5cm splittimg
O0= No *Geranium* essential oil O20= *Geranium* essential oil 4%
O5= *Geranium* essential oil 1% O40= *Geranium* essential oil 8%
O10= *Geranium* essential oil 2% O50= *Geranium* essential oil 10%

Dry matter percentage

Analysis of variance of data showed that effect of geranium extract, splitting and interaction of them are statistically significant at the 5% level (Table 1). Mean comparison of interaction of two factors showed that split treatment with 10% aromatic geranium extract with 32.41 percent, had the highest dry matter compared with the control with 24.69 percent (Fig. 5).

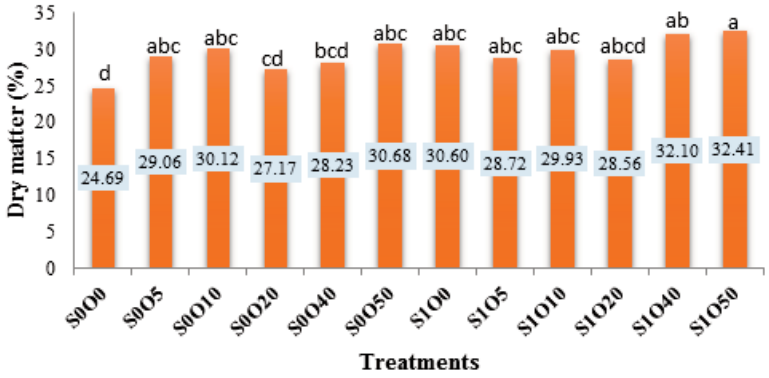

Fig. 5. Effects of mechanical and *Geranium* essential oil treatments on dry matter percent.

S0= Without splitting S1= With 5^{cm}splittimg
O0= No *Geranium* essential oil O20= *Geranium* essential oil 4%
O5= *Geranium* essential oil 1% O40= *Geranium* essential oil 8%
O10= *Geranium* essential oil 2% O50= *Geranium* essential oil 10%

Sucrose provides required energy for more survival of flowers and affects the structure of the flower tissues cell wall and delays aging through this and causes increasing the dry weight and the water retention (Sun and Gubler, 2004). Hashemabadi (2012) by an experiment on carnation cut flowers, showed that the effect of compounds extending the vase life of cut flowers on the prevention of dry weight loss by preventing the degradation of carbohydrates. Nabigol *et al*. (2006) showed that the antimicrobial compounds increase the biomass of chrysanthemum by controlling microorganisms and improving water uptake. In this study, split and geranium extract increase the absorption of water and sucrose in vase solution and the percentage of dry matter.

CONCLUSION

The results showed that the split of 5 cm and geranium extract causes significantly an increase in postharvest life of the chrysanthemum cut flowers. In current study, the split of 5 cm at the end of stem with 10% geranium extract improved the vase life of chrysanthemum cut flowers more than 10 days compared to control. Therefore, these treatments as an extended solution for the vase life of chrysanthemum cut flowers are recommended to retailers and consumers of this flower.

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