Physiological response of *Gerbera jamesonii* L. cut flowers to the cola and peppermint essence

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Abstract

This research was conducted to investigate the effects of peppermint (Mentha piperita) essence treatment (2000 mg L^{-1}) and cola soft drink treatment separately and in combination with each other on the vase life and some physiological characteristics of gerbera (Gerbera jamesonii) cut flowers with factorial arrangement in a completely randomized design with 3 replications. Distilled water used as control. The results showed that all treatments significantly increased the vase life, solution absorption, petal carotenoids, flower diameter, relative fresh weight, and petal total soluble solids in comparison with control. The highest and the lowest vase life were obtained in the peppermint essence plus cola soft drink treatment (250 ml L^{-1}) with 20.33 days and in the control with 9 days, respectively. The highest amounts of carotenoid, flower diameter, relative fresh weight, and total soluble solids were obtained in the peppermint essence plus cola soft drink treatment (250 ml L^{-1}). The highest amounts of solution absorption were obtained in flowers treated with cola soft drink (250 ml L^{-1}). In general, the results indicated that the peppermint essence as a safe and natural antimicrobial compound and the cola soft drink as a common drink having sugary and acid materials with easy access and being affordable could be used in gerbera cut flower preservative solution.

Key words: cola soft drink; Gerber; peppermint; vase life

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Introduction

Gerbera (*Gerbera jamesonii)* cut flower is one of the most important cut flowers and one of the world's top ten flowers (Nair et al., 2003). Gerbera value is due to its beautiful shiny ray florets. The flowers have a variety of colors including yellow, orange, pink, red, purple, and white. It is indigenous to the southern part of Africa, Madagascar, Asia, and Indonesia (Dole and Wilkins, 1999). Despite the popularity of gerbera flower, this flower is short-lived (He et al., 2006). Many research studies have been conducted to increase the vase life of cut flowers using different combinations. Although silver compounds are used as the preservative solution, silver is a heavy metal which contaminates the soil and groundwater (Dole and Schnelle, 1990). The use of organic acids such as citric acid has created the appropriate results for increasing the life of the cut flowers (Kiamohammadi and Hashemabadi, 2011; Lachinani, 2007; Lama et al., 2013). Citric acid

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increases the vase life of Rosa cut flowers by reducing the solution pH and controlling the activity of microbes in the vase solution (Nowak and Rudniki, 1990). Kazemi et al. (2012) have reported that the use of 100 and 150 mg L^{-1} of citric acid and 3% of sucrose increased vase life and water absorption of carnation cut flowers.

A study conducted in Shiraz to investigate the maintenance methods of cut flowers, reported that none of the respondents used commercial preservative solutions (Jowkar et al., 2010). Therefore, introducing simple and cheaper compounds with easy access is essential.

Carbonated soft drinks are one of the substances which can be used in vase solution of cut flowers (Ahmad and Dole, 2014). Carbonated soft drinks contain ingredients such as citric acid, phosphoric acid, sugar and benzoic acid (Maghsoudi, 2003). Providing a source of food in the form of carbohydrate is very important to supply the energy demand of the plant. By separating the flowers from the mother plant, the plant main source of nutrition is removed. In the absence of nutrients, the lack of carbohydrate in the plant damages the cut flowers. In the presence of environmentally inappropriate conditions, this process will be faster and more apparent (Nell, 2002). Ahmad and Dole (2014) reported that the use of Seven Up (500 ml L^{-1}) increased the vase life and fresh weight of Marigold cut flower.

Essential oils and extracts of medicinal plants are among the vase solutions which were used in the recent years. Essences of thyme, cinnamon, parsley, mint (Sharma and Trippathi, 2006), and eucalyptus (Tzortakis, 2007) have inhibitory effects on the growth of pathogens. Antibacterial factors prevent vascular obstruction. The use of *Thymus vulgaris* and *Zataria multiflora* essences in gerbera cut flower preservative solution increased its vase life (Solgi et al., 2009). Pirpour et al. (2013) have reported that peppermint essence treatment with concentrations of 100, 300, and 900 mg L^{-1} increased the quality and vase life of Lilium cut flowers.

The purpose of this experiment was to investigate the use of cola soft drink and peppermint essence separately and in combination with each other as a preservative solution to increase the vase life and some physiological characteristics of gerbera cut flower and to introduce it as a safe, inexpensive, and accessible solution probably suitable for gerbera flower.

Materials and Methods

In this experiment, commercially available gerbera cut flowers were purchased at Isfahan Veshareh Greenhouse. The flowers were transferred to the laboratory of Department of Horticultural Sciences, Gorgan University of Agricultural Sciences and Natural Resources under appropriate conditions (Within special cardboard and cellophane). The flowers were re-cut 30 cm below the water. They were then put in pre-prepared dishes containing vase solutions inside cabinet refrigerator (temperature of 9±2 °C, 400 lux of light with 12 hours of lightness and 12 hours of darkness and relative humidity of 65±5%). The treatments included peppermint essence (2000 mg L^{-1}), cola soft drink (250, 375, and 500 ml L^{-1}), and peppermint essence (2000 mg L^{-1}) plus cola soft drink (250, 375, and 500 ml L^{-1}). Distilled water was used as control. The soft drink was cola soft drink under Pepsi Cola brand containing sugar (10%), benzoic acid (150 mg L^{-1}), and phosphoric acid (150 mg L^{-1}) with pH 3.1. The peppermint essence was purchased from Isfahan Nature Extract Company. According to the analysis of the Center of Essence Supply, the constituents of this essence are shown in Table 1.

The measured parameters included the vase life, solution absorption, petal carotenoid, flower diameter, fresh weight, and total soluble solids. To measure the flowers vase life, some items including the petal wilting after 50%, the bent neck, and the brown stem were considered (Mutui et al., 2001). The solution absorption was calculated on the first, fifth, thirteenth, and seventeenth days of the experiment using a graduated cylinder through the following formula:

$$FW=\frac{(S_{t-1})-S_t}{w_{t=0}}$$

Fw: The amount of absorbed solution
S_t: Solution weight (g) in days 0, 3, etc.
S_{t-1}: Solution weight (g) in the previous day
$W_t = 0$: Stem fresh weight in day zero

To measure the carotenoid, Arnon method (1965) was used. After pulverizing the petals in a porcelain mortar and using acetone, the amount of carotenoid was determined on the basis of mg/fresh weight gram using a spectrophotometer at 480 and 510 nanometer wavelengths. This was conducted on the first, fifth, ninth, thirteenth, and seventeenth days of the experiment.To measure the flower diameter, digital caliper was used on the first, fourth, seventh, tenth, and thirteenth days of the experiment. The fresh weight of the flowers was measured on the first, fifth, ninth, thirteenth, and seventeenth days of the experiment using a digital scale through the following formula:

$\frac{w_t}{w_{t=0}} \times 100 =$ percentage of relative fresh weight (RFW)
W_t: Stem fresh weight in the same day and days 3, 6, ...
$W_t = 0$: Weight of the stem in day zero

This experiment has been conducted with factorial arrangement in a completely randomized design having 3 replications where each replication included 3 flowers. SAS software was employed to analyze the data. To compare the means, LSD test was used.

Results

Analysis of variance showed that the effect of treatment, time, and the interaction

Table 1
The constituents of the peppermint essence from Isfahan Nature Extract Company

Compounds	percent
Alpha- Pinene	1.72
Beta- Pinene	2.44
1,8 Cineole	6.82
Limonene	5.91
Alpha- Terpinene	0.43
Subinene	1.53
Neoiso- Menthol	1.32
Menthol	20.48
Cis- Dihydro carvone	2.32
Pipertone	1.6
Carvone	13.86
Menthyl acetate	2.12
Beta- Caryophyllene	3.2
Germacrene- D	3.47
Viridiflorol	1.39
Menthone	12.75
Trancs- Sabinehydrate	2.84
Neodihydro Carveol	4.47
Iso- Menthylacetate	0.28
Carvacrol	0.41
Neomenthol	7.63
Para- Cymene	0.98
Other compounds	2.03

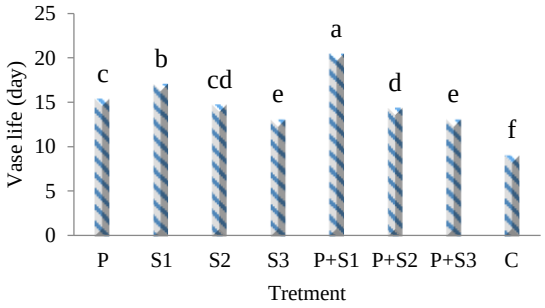

Fig. I. The effect of preservative solutions on the vase life of Gerbera cut flower;P: peppermint essence; S1: cola soft drink (250 ml L^{-1}); S2: cola soft drink (375 ml L^{-1}); S3: cola soft drink (500 ml L^{-1}); C: control

Table 2
Analysis of variance of the effect of treatment and time on measured characteristics of Gerbera cut flower

S.O.V	df	Solution absorption	Carotenoids	Flower diameter	Relative fresh weight	Total soluble solids
Treatment	7	0.825**	1.19**	3171.638**	4559.341**	67.129**
Time	4	7.02**	6.502**	38083.14**	27199.8972**	404.587**
Treatment*Time	28	0.946**	0.464**	1379.869**	1929.424**	16.993**
Error	80	0.0009	0.00006	0.791	0.339	0.006
Cv (%)	-	3.842	0.789	0.977	0.655	0.978

** Significant 1%

between treatment and time was significant in all measured characteristics at p≤0.01 (Table 2).

Vase life

Comparison of means showed that the longest vase life was related to the peppermint essence plus cola soft drink treatment (250 ml L^{-1}) with 20.33 days. The control had the lowest vase life with 9 days (Fig. I).

Solution absorption

The results of mean comparison showed that the highest and lowest solution absorption rates were obtained in cola soft drink treatment (250 ml L^{-1}) and control, respectively (Fig. II). Analysis of the solution absorption changes showed that the fifth day had the highest rate after which solution absorption decreased (Fig. III).

Carotenoid

Results of mean comparison showed that the highest and lowest petal carotenoid rates were obtained in flowers treated with peppermint essence + cola soft drink (250 ml L^{-1}) and control, respectively (Fig. II). Analysis of the carotenoid changes caused by time showed that the amount of carotenoid increased up to fifth day and then decreased (Fig. III).

Flower diameter

Results of mean comparison showed that the highest and lowest flower diameters were related to peppermint essence + cola soft drink (250 ml L^{-1}) and control, respectively (Fig. IV). The flower diameter changes caused by time showed that the flower diameter increased up to ninth day and then decreased (Fig. V).

Relative fresh weight

Results of mean comparison showed that the highest and lowest relative fresh weights were obtained in peppermint essence + cola soft drink treatment (250 ml L^{-1}) and control, respectively. There was no significant difference between the peppermint essence + cola soft drink treatment (250 ml L^{-1}) and cola soft drink treatment (250 ml L^{-1}) (Fig. iv). Study of the relative fresh weight

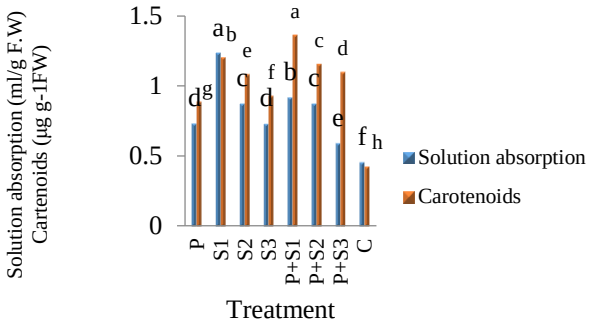

Fig. II. The effect of preservative solutions on solution absorption and carotenoid of Gerbera cut flowers;
P: peppermint essence; S1: cola soft drink (250 ml L^{-1}); S2: cola soft drink (375 ml L^{-1}); S3: cola soft drink (500 ml L^{-1}); C: control

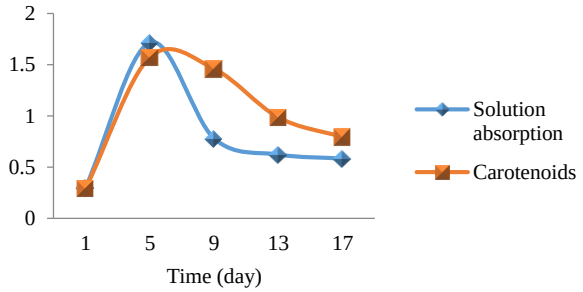

Fig. III. Changing process of solution absorption and carotenoids of Gerbera cut flower during the experiment

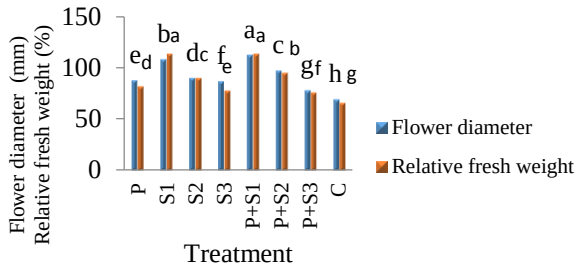

Fig. IV. The effect of preservative solutions on flower diameter and relative fresh weight of Gerbera cut flower;
P: peppermint essence; S1: cola soft drink (250 ml L^{-1}); S2: cola soft drink (375 ml L^{-1}); S3: cola soft drink (500 ml L^{-1}); C: control

changes caused by time showed that the relative fresh weight increased up to ninth day which was then decreased (Fig. V).

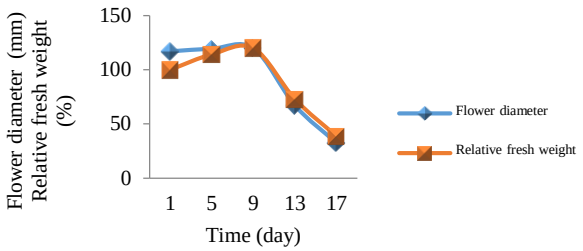

Fig. V. Changing process of flower diameter and relative fresh weight of Gerbera cut flower during the experiment

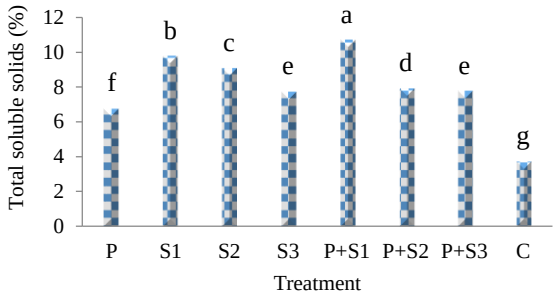

Fig. VI. The effect of preservative solutions on total soluble solids of Gerbera cut flower;
P: peppermint essence; S1: cola soft drink (250 ml L^{-1}); S2: cola soft drink (375 ml L^{-1}); S3: cola soft drink (500 ml L^{-1}); C: control

Total soluble solids

Results of mean comparison showed that the highest and lowest amounts of total soluble solids were obtained in peppermint essence + cola soft drink treatment (250 ml L^{-1}) and control, respectively (Fig. VI). Study of the total soluble solids changes caused by time showed that the highest amount of dissolved solids was obtained on seventh day which was then decreased (Fig. VII).

Discussion

In this study, the separate use of peppermint essence and cola soft drink provided lower vase life in comparison with their combined application. All treatments increased the vase life. This suggests that the cola soft drink having high percentage of sugar along with peppermint essence with antimicrobial properties increases the vase life. Nikkhah Eshghi and Kalate Jari (2013) have reported that the combination of *Thymus vulgaris* essence and sucrose increased the vase life and some qualitative characteristics of gladiolus cut flower. This is consistent with our findings. Water balance is the main factor determining the quality and vase life of cut flowers. The ability to absorb water and transpiration of cut flowers can make a balance between these two processes (Da silva, 2003). Sucrose is effective in maintaining the water balance for turgor. Therefore, adding the sucrose to the preservative solution increases the solution absorption in cut flowers (Nair et al., 2003). Inability to absorb water is one of the causes of flowers wilting. This may occur due to the growth of microorganisms in water conducting vessels of the stem (Halevy and Mayak, 1981). Citric acid as a pH-lowering substance prevents the proliferation of bacteria in the cut areas and improves the normal flow of water (Nowak and Rudnicki, 1999).

In this study, all treatments increased the carotenoid level. It seems that the combination of peppermint essence and cola soft drink is more

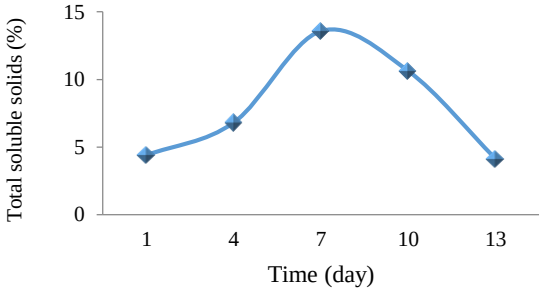

Fig. VII. Changing process of total soluble solids of Gerbera cut flower during the experiment

appropriate to keep the petal pigments. Petal discoloring is one of the problems after picking the cut flowers which reduces the flower quality and has a significant effect on senescence (Amarjit, 2000). Carotenoid and anthocyanin are two important pigments in cut flowers (Hassanpour Asil and Karimi, 2010). Antimicrobial compounds prevent the breakdown of flavonoids and make the flowers fresh by improving water absorption (Hashemabadi and Bagheri, 2013). The impact of natural compounds in increasing the petal carotenoid of cut flowers has been reported. Hashemabadi and Bagheri (2013) have stated that the treatment of Chrysanthemum cut flower with tea extract increased the petal carotenoid. In a

study reported by Babarabie et al. (2014), the use of cola soft drink increased the petal anthocyanin of Alstroemeria cut flowers.

In the present study, it seems that the peppermint essence makes the cola soft drink absorbable for flowers. The flower diameter increased through consumption of soft drink sugar. The petals growth associated with flower opening is the result of cell development (Knee, 2000). Cell development needs water flow and osmolyte materials such as carbohydrates into petal cells (Evans et al., 1988). Talukdar and Barooah (2011) have stated that the citric acid and sucrose treatment increased the floret diameter of *Polianthes tuberosa*. In their study, Hashemi et al. (2011) used thymol, menthol, and eugenol in gerbera cut flower preservative solution and reported that all treatments increased the flower diameter and thymol performed better.

One of the most important factors determining the vase life and quality of flowers is the relative fresh weight. The lower water reduction (fresh weight reduction) makes the vase life longer (Haji Raza et al., 2012). In this case, by examining the effect of Seven Up soft drink on cut flowers of Rosa, Marigold and Sunflower, Ahmed and Dole (2014) have reported that the Seven Up soft drink delayed the fresh weight reduction in cut flowers and increased their vase life. This is compatible with the findings of the current research. Application of thyme, Carum carvi, and peppermint essences in the carnation cut flower preservative solution delayed the fresh weight reduction in comparison with control (Karimian Fariman and Tehranifar, 2011). These researchers also reported that among the treatments, the peppermint essence was more effective.

In the present study, all treatments which increased the total soluble solids increased the vase life as well. This confirms the relationship between these two variables. It seems that cola soft drink having a combination of sucrose and acidic substances increases the total soluble solids. The role of exogenous sugar in extending the life of flowers is well known. The sugar absorbed from solution is collected in petal tissue, improving the osmotic potential and increasing the amount of required carbohydrates (Sarkka, 2004). Also, it increases the total soluble solids. Hashemi and Mirdehghan (2014) have reported that the treatment of carnation cut flower with eugenol, thymol, and menthol, extracted from herbal essences increased the total soluble solids of petal. The results of the study reported by Rezaeinejad and Hasanvand (2013) indicated that the use of sucrose in Rosa cut flower preservative solution increased the total soluble solids of petal. There is a direct relationship between the concentration of sugar in the petal and flower life (Ishimora and Ueyama, 1998).

Conclusion

The results showed that the separate treatments of peppermint essence and cola soft drink and also their combination increased the vase life and some physiological characteristics of gerbera cut flowers. It was also found that the best concentration of cola soft drink was 250 ml L^{-1}. The use of peppermint essence in gerbera cut flower preservative solution was suitable and important due to its favorable properties such as antimicrobial properties. The cola soft drink as a common drink containing sugary and acid materials is easily available and affordable. Therefore, it can be used in gerbera cut flower preservative solution.

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