

Enhancing vase life of *Helianthus annuus* L cut flowers using Salicylic Acid and Dill essential oil

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ABSTRACT

The aim of the present study was to evaluate the effect of dill oil and salicylic acid on the vase life of *Helianthus annuus* L. Experiments were carried out in the laboratory of the Ornamental Horticulture Dep., Fac. of Agric., Cairo Univ., Giza, Egypt, during the two successive seasons 2018 and 2019. Flower diameter, relative fresh weight, water uptake, bacterial count, chlorophyll content, total carbohydrates, total phenols, protein content and anthocyanin. Distilled water was used as a control; while dill oil rates at 50, 100 and 200 mg/l, supplemented or not with salicylic acid (100 and 200 ppm) were applied by adding to the holding solution. The addition of dill oil at rate of 200 mg/l combined with salicylic acid at 200 ppm to holding solution increased vase life, water uptake, and flower diameter in both seasons compared to the control (distilled water). The highest value of relative fresh weight obtained from flowers holding in vase solution containing dill oil at rate of 50 mg/l combined with salicylic acid at rate of 200 ppm. On the other hand, bacterial count decreased with holding flowers at vase solution containing dill oil at rate of 100 and 200 mg/l combined with salicylic acid at rate of 200 ppm compared to the control and other treatments. The maximum value of chlorophyll content, total carbohydrates, total phenols, protein content and anthocyanin obtained from flowers treated by dill oil at 200 mg/l combined with salicylic acid at rate of 200 ppm.

Keywords: sun flower, dill oil, salicylic acid, anthocyanin, bacterial.

Introduction

The common sunflower (*Helianthus annuus*) is an annual sunflower plant form of the genus *Helianthus* belong to Family Asteraceae Abdel-Moniem (2016). It is grown as a crop for its edible oil and edible fruits. This sunflower species is also used as wild bird food, livestock forage, and ornamental in domestic gardens Jones *et al.*, (1993). Recently sunflowers show an increase in the cultivation for ornamental use, outdoors and cut flowers and the greenhouse (Blacquièrè *et al.*, 2002).

Nowadays, post-harvest treatments deliver flowers to customers with optimal quality (Patel *et al.*, 2018). Post-harvest of cut flowers affected by many factors such as chemical factors, environment, agronomical, and plant genetics. Moreover, biotic and abiotic stress like water stress and microorganisms can affect on vase life of the cut flower Bidarigh, 2015). In the past, flowers companies used a lot of preservatives. In recent years, essential oils have a positively effect as preservatives and their effects on water uptake, relative fresh weight, and freshness of flowers. (Bayat *et al.*, 2013).

The essential oils are a volatile aromatic substance extracted from different parts of the plant for example, leaves, seeds, fruits, roots, and flowers (Bayat *et al.*, 2013). Essential oils have a great role as environmentally friendly properties affecting the floriculture industry due to antimicrobial properties and its improving freshness of cut flowers and prolonging the post-harvest duration (Banjaw *et al.*, 2017). Aromatic oils are natural organic substances that are eco-friendly and safe. Essential oils can be used as antibacterial, antifungal, antioxidant, and anti-carcinogenic properties so the essential oils are used in a lot of foods as natural additives. Dill oil, clove oil, Lavender oil, Thyme oil, and Geranium oil have the optimal effect on bacteria and fungi (Patel *et al.*, 2018).

Dill (*Anethum graveolens* L.) is an annual plant that belongs to the Apiaceae family. The main components of dill oil are carvone, α -phellandrene, and limonene (Carrubba and Catalano, 2011). Salicylic acid is a type of phenolic acid that can inhibit aminocyclopropanecarboxylate oxidase activity that is a direct affect ethylene and decrease ROS with increase enzyme antioxidant activity (Heidarnezhdian *et al.*, 2017). Hashemabadi (2014) found that Artemisia and Anethum oils were the optimal treatments and improved vase life and qualitative features of carnation cut flower.

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In this work, we aimed to study the effect of dill essential oils and salicylic acid on the postharvest life characteristic (cut flowers, water relations, chemical composition, and to evaluate their antibacterial activity) of sunflower cut flowers.

Material and Methods

This study was carried out in the laboratory of the Ornamental Horticulture Dep., Fac. of Agric., Cairo Univ., Giza, Egypt, during the two successive seasons 2018 and 2019 (from 10 to 25 January in both seasons). The purpose of this experiment was to evaluate the effects of using some natural essential oils as preservative solutions on the vase life of sunflower plants (*Helianthus annuus* cv. sunrich orange summer).

Plants and Preparation of Treatments:

The sunflower (*Helianthus annuus* sunrich orange summer) was obtained from the commercial growing farm "Floramix Farm" flowers. The flowers were individually placed in bottles containing 250 ml of preservative (Holding) solution and were held at ambient temperature ($20 \pm 5^\circ\text{C}$) humidity 50%-70%, scattered light in daytime and keep the natural dark from 9 pm to 7 am of the next day. The indicators of preservation of sunflower cut flowers were detected every day at 10 am.

Then the following treatments were conducted:

- 1- Untreated flowers were held in distilled water (control)
- 2- Essential oils extraction solutions (Dill oil) at the levels of 50, 100, and 200 mg/l.
- 3- Salicylic acid at 100 and 200 ppm.

In addition, 0.3% of sucrose as carbon source for all applied treatments.

Data recorded:

1. Flower vase life (days)

In both seasons, the vase life was determined as the number of days to wilting of flowers (Nabigol *et al.*, 2005).

2. Flower diameter (cm).

3. Flowers dry weight (g).

4. Relative fresh weight (RFW %)

The cut flowers were initially weighed at first six days of the experiment 1, 2, 3, 4, 5, and 6, and at the vase life of the control flowers. Relative fresh weight of stems was calculated using the following formula: $\text{FW (\%)} = \text{Fresh weight of stem in mentioned day} / \text{Fresh weight of stem in zero day} \times 100$ according to He *et al.*, (2006):

5. Water uptake (cm/flower/day)

Water uptake ($\text{g stem}^{-1} \text{d}^{-1}$) = $(st-1-st)$, whereas, weight of vase solution (g) at $t =$ days 1, 2, 3, etc., and $st-1$ is weight of vase solution (g) on the previous day according to Hatami *et al.*, (2013).

6. Bacterial count

Averages of bacteria counts (Colonies/ml): Bacterial contamination was determined in the keeping solution incubated for 48 h. The samples of the preservative solutions were taken (1 ml of each) and diluted using sterilized distilled water. One ml of each diluted solution was streaked on nutrient agar into Petri dishes. Cultures were incubated 2-3 days at 28°C and the colonies appearing on the plates were counted as described by Marousky (1969).

7. Chlorophyll a and b content and carotenoids (mg/ g FW)

Chlorophyll a, chlorophyll b and carotenoids (mg/g F.W.) were determined in fresh leaf samples on the sixth day according to Saric *et al.* (1967).

8. Total carbohydrates in leaves and flowers

The concentration of total carbohydrates was determined in the leaves and flowers on the sixth day using the method described by Herbert *et al.* (1971).

9. Total phenols% and Protein content %:

The phenols content was determined using Folin- Ciocalteu reagent method according to Singleton *et al.*, 1999 and Protein content % according to A.O.A.C. (1995).

10. Anthocyanins (%) in flowers: were determined calorimetrically according to Husia *et al.*, (1965).

Statistical Analysis

The data were analyzed using a randomized complete design with 12 treatments (three replicates per treatment). The treatments average was compared for significance by new multiple range tests at the 0.05% level of probability (Little and Hills, 1978).

Results and Discussion

1- Vase life

The data in Table (1) showed that the effect of treatments on the vase life of sunflower. The treatments of dill oil and salicylic acid caused a significant increase in the vase life of sunflower compared to the control. Data in Table (1) indicated that in both seasons, dill oil at the rate of 200 mg/l combined with salicylic acid at rate of 200 ppm (T12) gave the highest value of the vase life of sunflower (15 and 16 days in the first and second season, respectively). Regarding the positive effect of salicylic acid without adding dill oil on vase life of sunflower which salicylic acid at 200 ppm (T9) gave the highest value of vase life compared to the control and the other salicylic rates (13 and 13 days in the first and second season, respectively). On the other hand, the shortest vase life of sunflower in the first season obtained from dill oil at the rate of 200 mg/l combined with salicylic acid at rate of 100 ppm but in the second season obtained from dill oil at rate of 50 and 100 mg/l.

Table 1: Effect of dill oil and salicylic acid application on vase life (days), flower diameter and flower (cm) dry weight of flowers (g) of sunflowers (*Helianthus annuus*) during 2018 and 2019 seasons.

| Treatments | First season | Second season | First season | Second season | First season | Second season |
|------------|-------------------|----------------------|----------------------|-----------------------|------------------------|------------------------|
| | Vase life (days) | | Flower diameter (cm) | | Flower dry weight(g) | |
| T1 | 8 d ^e | 8 d ^e | 15.63 a ^b | 17.43 a ^b | 8.12 f ^g | 8.763 f ^{gh} |
| T2 | 9 d | 7 e | 13.4 b | 13.2 b ^c | 9.833 d ^{efg} | 6.967 h |
| T3 | 11 c | 7 e | 15.23 a ^b | 16.37 a ^{bc} | 10.68 d ^{efg} | 7.587 g ^h |
| T4 | 7 e ^f | 8 d ^e | 16.47 a ^b | 16.1 a ^{bc} | 9.453 e ^{fg} | 11.9 c ^{def} |
| T5 | 11 c | 9 d | 15.5 a ^b | 16.4 a ^{bc} | 7.557 g | 11.14 d ^{efg} |
| T6 | 11 c | 11 c | 15.03 a ^b | 15.03 a ^{bc} | 11.53 c ^{def} | 10.06 e ^{fgh} |
| T7 | 7 e ^f | 8 d ^e | 16.33 a ^b | 17.37 a ^{bc} | 15.27 b ^c | 14.1 b ^{cd} |
| T8 | 6 f | 11.67 b ^c | 13.9 b | 12.9 c | 13.46 c ^d | 15.36 b ^c |
| T9 | 13 b | 13 b | 16.8 a ^b | 17.3 a ^{bc} | 12.21 c ^{de} | 12.76 c ^{de} |
| T10 | 14 a ^b | 11 c | 14.93 a ^b | 17.3 a ^{bc} | 18.86 a ^b | 17.19 a ^b |
| T11 | 13 b | 12 b ^c | 15.53 a ^b | 15.87 a ^{bc} | 19.38 a | 20.16 a |
| T12 | 15 a | 16 a | 18.87 a | 18.73 a | 21.24 a | 19.64 a |

*T1=control, T2=dill oil at 50 mg/l, T3= dill oil at 100 mg/l, T4= dill oil at 200 mg/l, T5=salicylic acid at 100 ppm, T6= dill oil at 50 mg/l and salicylic acid at 100 ppm, T7= dill oil at 100 mg/l and salicylic acid at 100 ppm, T8= dill oil at 200 mg/l and salicylic acid at 100 ppm, T9= salicylic acid at 200 ppm, T10= dill oil at 50 mg/l and salicylic acid at 200 ppm, T11= dill oil at 100 mg/l and salicylic acid at 200 ppm, T12= dill oil at 200 mg/l and salicylic acid at 200 ppm

These results are in harmony with those of Saini *et al.*, (1994), who indicated that using different concentrations of essential oils in vase solution of tuberose cut flowers increased the vase life of flowers. Jamshidi *et al.*, 2012 found that using salicylic acid increased the vase life of Gerbera cut flowers. Shanan *et al.*, (2010) found that the highest value of vase life (15.60 days and 16.80 days) in carnation flowers were observed with treatment of dill EO (50 mg/l). Also, Kazemi *et al.*, 2018 found that the application of salicylic acid on vase solution improve the vase life of cut rose flowers. Yuping (2009) reported that salicylic acid treatment had a significant effect on the vase life of *gerbera jamesonii*.

2. Flower diameter (cm)

The data in Table (1) showed that holding sunflowers cut flowers in vase solution containing on dill oil at the rate of 200 mg/l combined with salicylic acid at rate of 200 ppm gave the highest diameter of flowers in both seasons (18.87 and 18.73 cm in the first and second season, respectively). Moreover, at first the lowest value of flowers diameter obtained from holding sunflowers cut flowers in vase solution containing dill oil at the rate of 50 mg/l (13.40 cm) but in the second season obtained from holding sunflowers cut flowers in vase solution containing dill oil at rate of 100 mg/l combined with salicylic acid at rate of 100 ppm (12.90 cm). Babarabie *et al.*, (2016) found that Rosemary essential oil increased the diameter of *Alstroemeria* cut flowers. Also, Jahanbazi *et al.*, (2014) found that using salicylic acid (SA) had the maximum diameter of the flower of rose.

3. Flower dry weight (g)

Data presented in Table (1) showed the effect of dill oil and salicylic acid on the flower dry weight. The highest value of dry flower weight in both seasons obtained from flowers holding on vase solution containing a dill oil at the rate of 100 mg/l combined with salicylic acid at rate of 200 ppm and dill oil at rate of 200 mg/l combined with salicylic acid at rate of 200 ppm (19.38, 21.24 and 20.16, 19.64 in the first and second season, respectively) compared to the control and the other treatments. Similar results reported by Dashtbany *et al.*, (2015) on chrysanthemum reported that the highest dry matter (32.41 %) was achieved with *Geranium* essential oil.

4. Relative fresh weight (RFW %)

The results of the analysis of variance showed that the effect of dill oil and salicylic acid application on the relative fresh weight of sunflower. The maximum relative fresh weight of sunflower in the first season obtained from dill oil at rate of 50 mg/l combined with salicylic acid at the rate of 200 ppm in the first season (97.48%). However, the minimum relative fresh weight of sunflower in the first season obtained from dill oil at rate of 50 mg/l (86.96%). In the second season the maximum relative fresh weight of sunflower obtained from dill oil at rate of 200 mg/l combined with salicylic acid at rate of 200 ppm (96.38%) but the minimum relative fresh weight of sunflower in the first season obtained from dill oil at rate of 100 mg/l (87.79). Regarding the effect of salicylic acid on relative fresh weight, it has a significant effect on the relative fresh weight of sunflower. The data in fig. (1) indicated that the salicylic acid at rate of 200 ppm gave the highest values of relative fresh weight compared to control. Bayat *et al.*, 2013 found that a positive response of essential oil on relative fresh weight flower. Solgi *et al.*, 2009 found that the addition of 100mg/ L essential oils and 1 or 2mg/L SNP increased the relative fresh weight of gerbera flowers compared to the control flowers. Marandi *et al.*, (2011) showed that salicylic acid and ajowan oil at 500 ppm concentration had an optical effect on fresh weight (%) of cut gladiolus.

5. Water uptake (cm/flower/day)

Water uptake increased during holding sunflowers cut flowers in vase solution containing dill oil at the rate of 200 mg/l combined with salicylic acid at the rate of 200 ppm in both seasons (17.17 and 16.33 cm in the first and second season, respectively). Alternatively, control flowers have the lowest value of water uptake followed by holding sunflowers cut flowers in vase solution containing dill oil at rate of 50 and 100 mg/l. Solgi *et al.*, 2009 obtained that using 100mg L⁻¹ essential oils and 1 or 2 mgL⁻¹ SNP increased the solution uptake of gerbera flowers. Also, Zamani *et al.*, 2011 showed that the water uptake increased with the solution containing 1.5 mM Salicylic on rose flowers compared to the control. Marandi *et al.*, (2011) determined that cut gladiolus of flowers pulsing in vase solution containing with

ajowan oil at 500 ppm concentration in combination with salicylic acid and sucrose 4% had the best effect on water uptake.

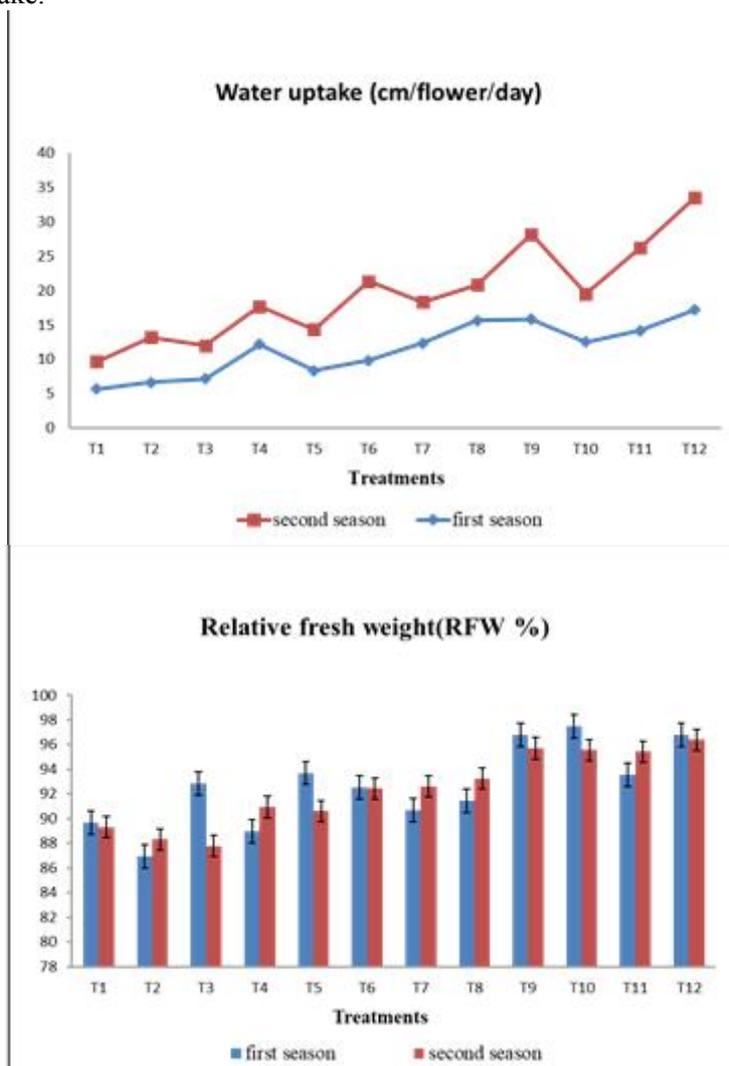


Fig. 1: Effect of dill oil and salicylic acid application on relative fresh weight (RFW%) and water uptake (cm/ flower/day) of sunflowers (*Helianthus annuus*) during 2018 and 2019 seasons.

*T1=control, T2=dill oil at 50 mg/l,T3= dill oil at 100 mg/l,T4= dill oil at 200 mg/l, T5=salicylic acid at 100 ppm, T6= dill oil at 50 mg/l and salicylic acid at 100 ppm, T7= dill oil at 100 mg/l and salicylic acid at 100 ppm, T8= dill oil at 200 mg/l and salicylic acid at 100 ppm, T9= salicylic acid at 200 ppm, T10= dill oil at 50 mg/l and salicylic acid at 200 ppm, T11= dill oil at 100 mg/l and salicylic acid at 200 ppm,T12= dill oil at 200 mg/l and salicylic acid at 200 ppm

2- Bacterial count

In our study, data in fig. (2) showed that dill oil effect slightly on the number of bacteria in the vase solution. The effect of dill oil was significant with increasing the concentration of dill oil. On the other hand, using dill oil combined with salicylic acid gave the lowest number of bacteria in the vase solution than control and other treatments. Data in fig.2 revealed that control plants gave the largest number of bacteria in the vase solution. Moreover, vase solution with dill oil at rate of 100 and 200 mg/l combined with salicylic acid at rate of 200 ppm had the minimum number of bacteria in the vase solution. Maneerung *et al.* (2008) and Navarro *et al.* (2008) reported that the effects of cumin essential oil and dill essential oils had a positive effect against micro-organisms. Kazemi and Ameri (2012) investigated that essential oils and silver nanoparticles and salicylic acid on bacterial count of carnation had a significantly reduced on bacterial populations much more than the control. Also, in many paper, antimicrobial properties of essential oils of plants related to their phenolic constituents. The phenolic constituents affect cell membrane permeability, and may disintegrate the outer membrane of gram-

negative bacteria (Marandi *et al.*, 2011, Bagamboula *et al.*, 2004 and Burt, 2004). Several studies indicated that salicylic acid had a positive effect against pathogens and for the inducible defense mechanism, systemic acquired resistance, which confers resistance against a broad-spectrum of pathogens (Marandi *et al.*, 2011 and Chaturvedi and Shah, 2007).

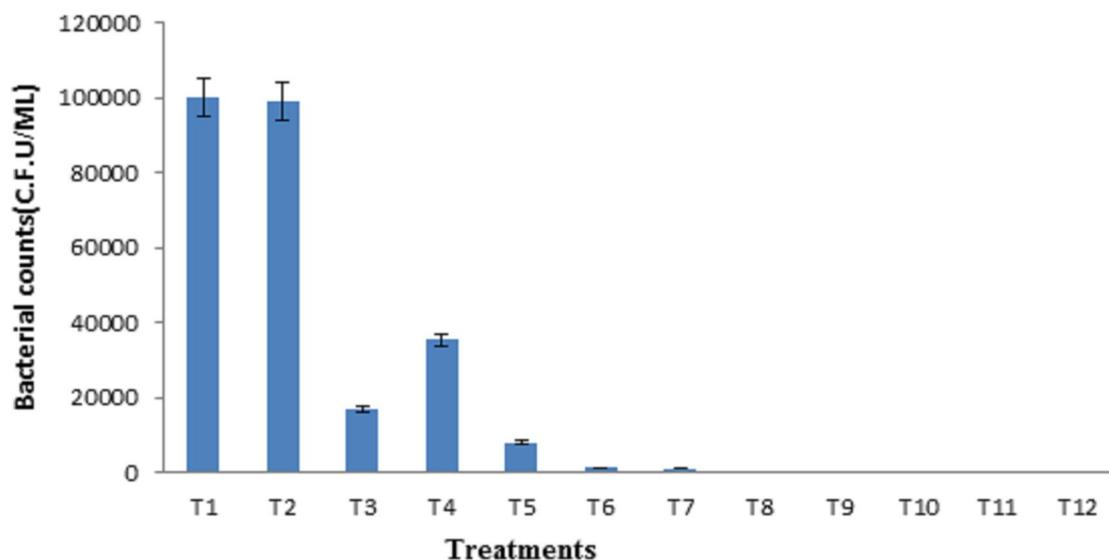
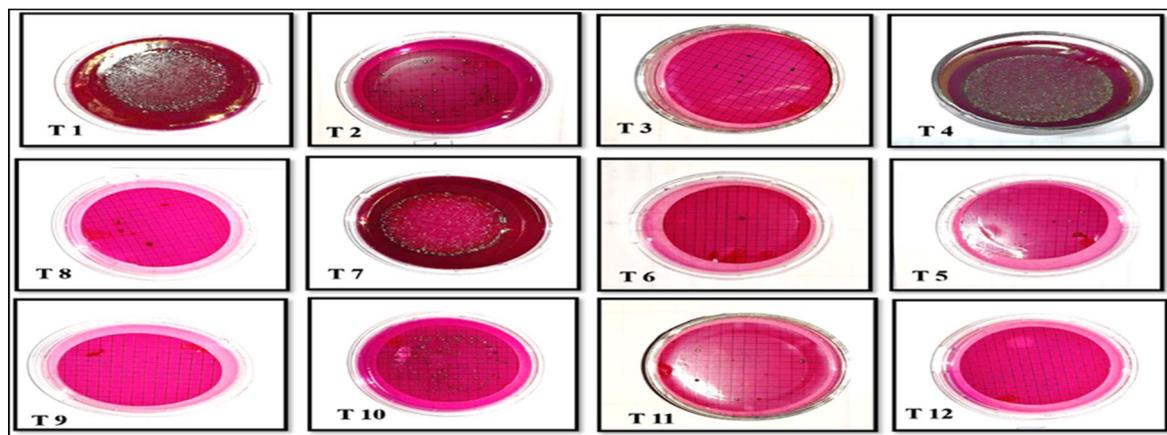


Fig. 2: Effect of dill oil and salicylic acid application on bacterial count of sunflowers (*Helianthus annuus*) during 2018 and 2019 seasons.

*T1=control, T2=dill oil at 50 mg/l, T3= dill oil at 100 mg/l, T4= dill oil at 200 mg/l, T5=salicylic acid at 100 ppm, T6= dill oil at 50 mg/l and salicylic acid at 100 ppm, T7= dill oil at 100 mg/l and salicylic acid at 100 ppm, T8= dill oil at 200 mg/l and salicylic acid at 100 ppm, T9= salicylic acid at 200 ppm, T10= dill oil at 50 mg/l and salicylic acid at 200 ppm, T11= dill oil at 100 mg/l and salicylic acid at 200 ppm, T12= dill oil at 200 mg/l and salicylic acid at 200 ppm

3- Chlorophyll a and b content and total carotenoids (mg/ g F.W.)

Data in Fig. (3) indicated that the highest value of chlorophyll a in both seasons was obtained from sunflowers treated with dill oil at 200 mg/l and salicylic acid at 200 ppm. On the other hand, the lowest value of chlorophyll a in both seasons obtained from sunflowers treated with dill oil at 50 mg/l. In both seasons, sunflowers pulsing in vase solution containing dill oil at 200 mg/l and salicylic acid at 100 ppm gave the highest value of chlorophyll b and carotenoids content. These results are in harmony with Heidarneshadian *et al.* (2017), who found that the vase solution containing 1.5 mM SA significantly increased total chlorophyll content of gerbera. Kazemi *et al.* (2011) also found that adding salicylic acid in the vase solution of Lisianthus flower increased chlorophyll content cut flowers. Canakci, (2008) reported that treatment of radish flower with salicylic acid significantly increase the chlorophyll content.

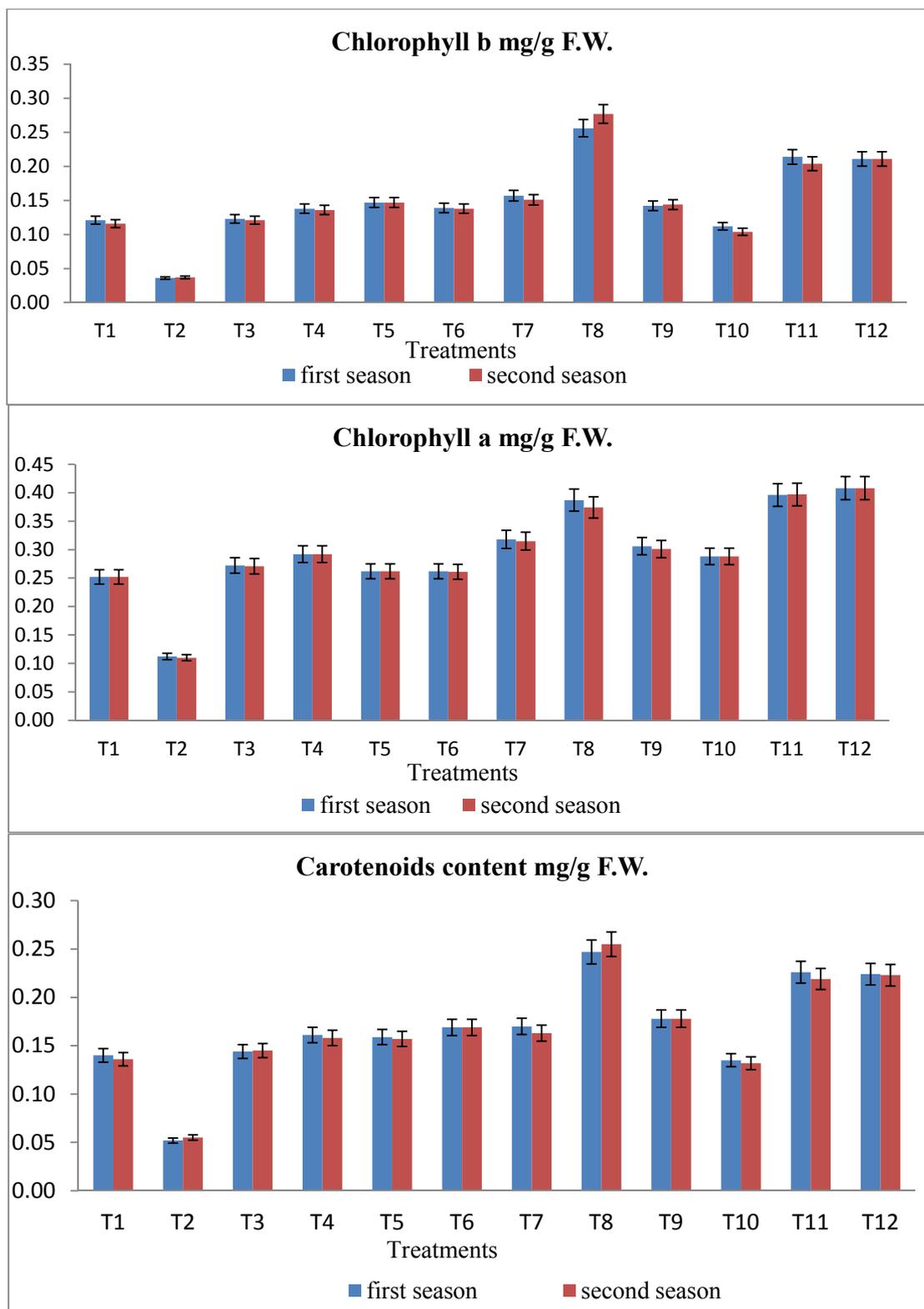


Fig. 3: Effect of dill oil and salicylic acid application on chlorophyll A, chlorophyll b and carotenoids content of sunflowers (*Helianthus annuus*) during 2018 and 2019 seasons.
 *T1=control, T2=dill oil at 50 mg/l,T3= dill oil at 100 mg/l,T4= dill oil at 200 mg/l, T5=salicylic acid at 100 ppm, T6= dill oil at 50 mg/l and salicylic acid at 100 ppm, T7= dill oil at 100 mg/l and salicylic acid at 100 ppm, T8= dill oil at 200 mg/l and salicylic acid at 100 ppm, T9= salicylic acid at 200 ppm, T10= dill oil at 50 mg/l and salicylic acid at 200 ppm, T11= dill oil at 100 mg/l and salicylic acid at 200 ppm,T12= dill oil at 200 mg/l and salicylic acid at 200 ppm

4. Total carbohydrates%

a) Total carbohydrates in leaves %

The acquired data from sunflowers on total carbohydrates in leaves represented in Fig. (4) indicated that the use of dill oil combined with salicylic acid had the optical value of total carbohydrates in leaves. In both seasons, the highest value of total carbohydrates in leaves obtained from flowers pulsing in vase solution continue on dill oil at the rate of 50 mg/l combined with salicylic acid at the rate of 200 ppm (24.14 and 24.05 % in the first and second season, respectively). On the other hand, flowers pulsing in vase solution continue on dill oil at rate of 200 mg/l gave the lowest value of total carbohydrates in leaves in both seasons (7.93 and 7.86 % in the first and second season, respectively). Results was obtained agreed with El-Sheshtawy and El-Serafy, 2016 indicated that using essential oils increased total carbohydrate in chrysanthemum cut flowers.

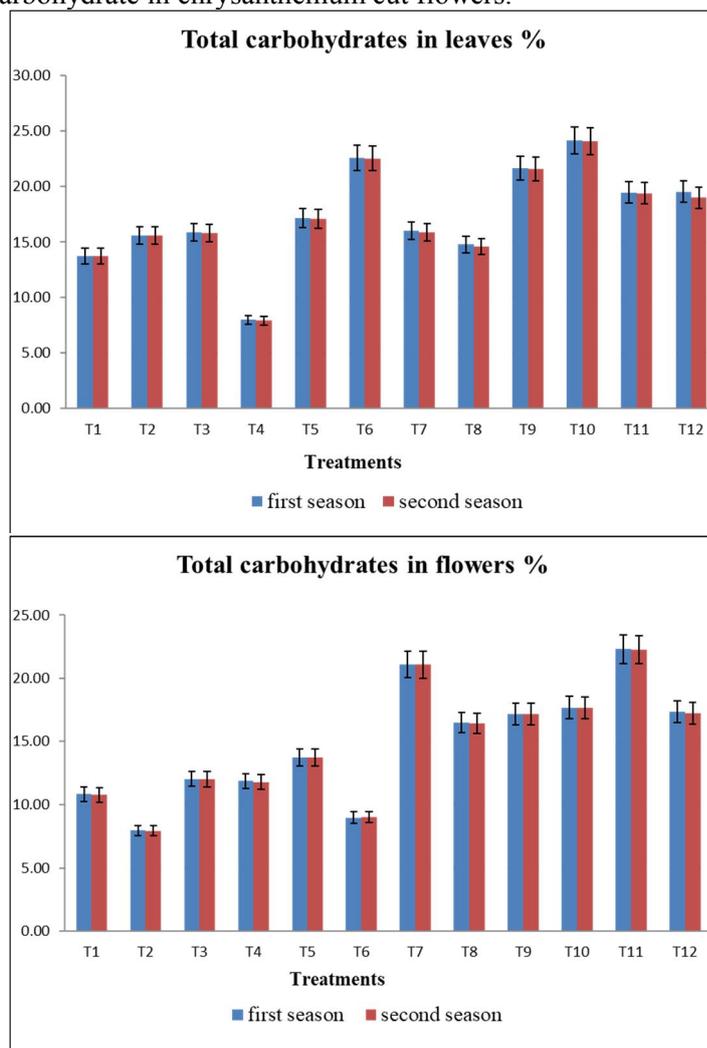


Fig. 4: Effect of dill oil and salicylic acid application on total carbohydrates in leaves and flowers of sunflowers (*Helianthus annuus*) during 2018 and 2019 seasons.

*T1=control, T2=dill oil at 50 mg/l, T3= dill oil at 100 mg/l, T4= dill oil at 200 mg/l, T5=salicylic acid at 100 ppm, T6= dill oil at 50 mg/l and salicylic acid at 100 ppm, T7= dill oil at 100 mg/l and salicylic acid at 100 ppm, T8= dill oil at 200 mg/l and salicylic acid at 100 ppm, T9= salicylic acid at 200 ppm, T10= dill oil at 50 mg/l and salicylic acid at 200 ppm, T11= dill oil at 100 mg/l and salicylic acid at 200 ppm, T12= dill oil at 200 mg/l and salicylic acid at 200 ppm

b) Total carbohydrates in flowers %

Data presented in Fig. (4) show the effect of dill oil and salicylic acid on total carbohydrates in leaves of sunflowers in both seasons. In both seasons, treated sunflowers with dill oil at the rate of 100 mg/l combined with salicylic acid at rate of 200 ppm gave the highest value of total carbohydrates in flowers 22.28 and 22.24 % in the first and the second seasons, respectively. However, in both seasons,

the lowest values of total carbohydrates in the flowers obtained from flowers pulsing in vase solution continue on dill oil at the rate of 50 mg/l (7.95 and 7.93% in the first and second season, respectively).

4- Total phenols and protein content %

Data presented in fig. (5) show the effect of dill oil and salicylic acid on total phenols and total protein content in both seasons. The results in the same figures, show that treated sunflowers by dill oil at the rate of 200 mg/l combined with salicylic acid at rate of 200 ppm gave the highest value of total phenols and total protein content in both seasons.

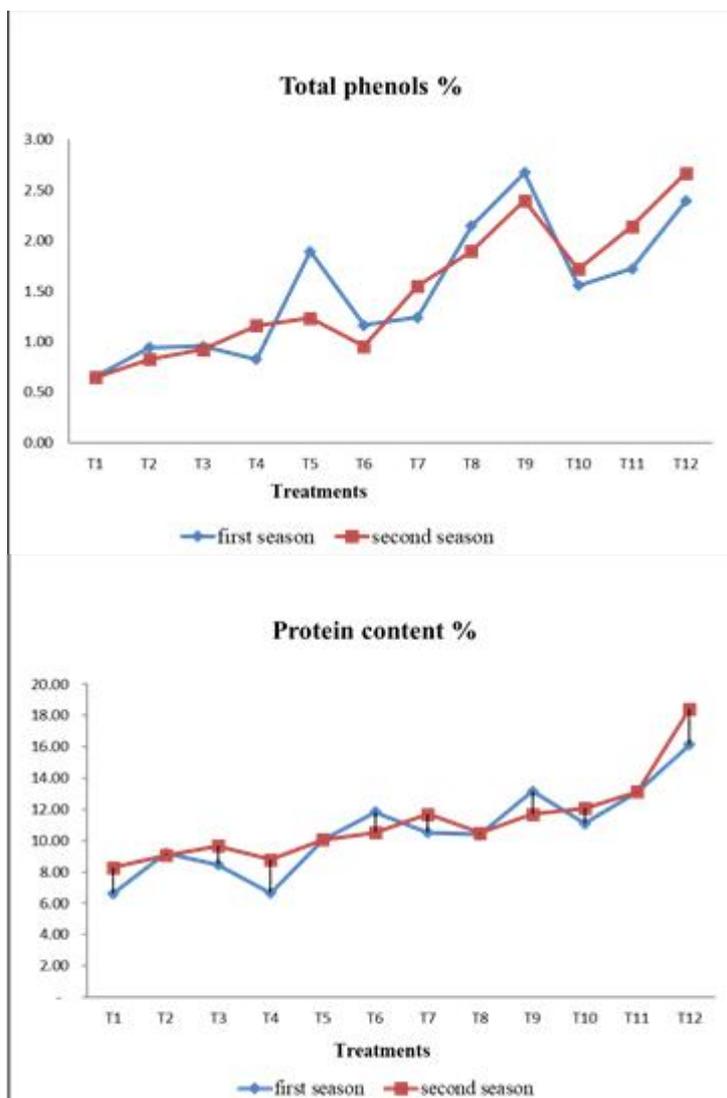


Fig. 5: Effect of dill oil and salicylic acid application on total phenols and protein content of sunflowers (*Helianthus annuus*) during 2018 and 2019 seasons.

*T1=control, T2=dill oil at 50 mg/l, T3= dill oil at 100 mg/l, T4= dill oil at 200 mg/l, T5=salicylic acid at 100 ppm, T6= dill oil at 50 mg/l and salicylic acid at 100 ppm, T7= dill oil at 100 mg/l and salicylic acid at 100 ppm, T8= dill oil at 200 mg/l and salicylic acid at 100 ppm, T9= salicylic acid at 200 ppm, T10= dill oil at 50 mg/l and salicylic acid at 200 ppm, T11= dill oil at 100 mg/l and salicylic acid at 200 ppm, T12= dill oil at 200 mg/l and salicylic acid at 200 ppm.

The average of total phenols was 2.39 and 2.66 % in the first and second seasons, respectively, but the average of total phenols was 16.13 and 18.43 % in the first and second season, respectively. On the other hand, the lowest value was obtained from control plants. The results in agreement with a prior study on Rosa hybrid (Gebremedhin *et al.*, 2013).

5- Anthocyanin in flowers g/100g

According to data listed in fig. 6, it can be concluded that the highest value of anthocyanin in flowers was recorded in both seasons by using dill oil at rate of 200 mg/l combined with salicylic acid at the rate of 200 ppm. The other treatments induced a slightly increase in anthocyanin contents in flowers. Furthermore, flowers pulsing in vase solution continue on dill oil at the rate of 50 mg/l gave the lowest value of anthocyanin contents in flowers. Heidarneshadian *et al.* (2017) who, found that the vase solution containing SA increased the anthocyanin content of gerbera flowers. The highest value of anthocyanin obtained from 2mM salicylic acid (Zamani *et al.*, 2011).

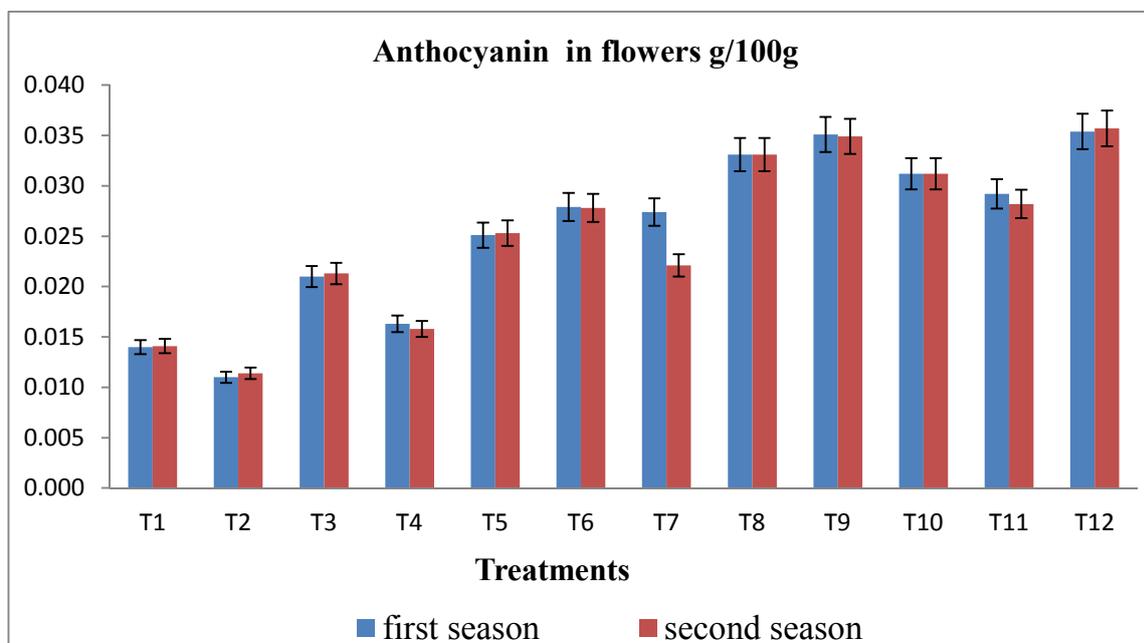


Fig. 6: Effect of dill oil and salicylic acid application on anthocyanin content of sunflowers (*Helianthus annuus*) during 2018 and 2019 seasons.

*T1=control, T2=dill oil at 50 mg/l, T3= dill oil at 100 mg/l, T4= dill oil at 200 mg/l, T5=salicylic acid at 100 ppm, T6= dill oil at 50 mg/l and salicylic acid at 100 ppm, T7= dill oil at 100 mg/l and salicylic acid at 100 ppm, T8= dill oil at 200 mg/l and salicylic acid at 100 ppm, T9= salicylic acid at 200 ppm, T10= dill oil at 50 mg/l and salicylic acid at 200 ppm, T11= dill oil at 100 mg/l and salicylic acid at 200 ppm, T12= dill oil at 200 mg/l and salicylic acid at 200 ppm

Conclusion

In conclusion, using various concentrations of essential oils and salicylic acid in preservative solutions of sunflowers (*Helianthus annuus*) showed the optimal effect of utilizing natural essential oils or salicylic acid in extending sunflowers vase-life. Moreover, inhibition bacteria activity in the vase solution and was more effective with using dill oil combining with salicylic acid.

References

- Abdel-Moniem, A.M., 2016. Effect of some growth retardants on growth and Flowering of *Helianthus annuus* l. Cv. Sunrich orange summer 981v plants B- application of ancymidol, daminozide and ethephon in combinations. Scientific J. Flowers & Ornamental Plants, 3(2):119-134.
- AOAC, 1995. Official methods of analysis (16th Ed.. Washington, DC: Association of Official Analytical Chemists.
- Babarabie M., H. Zarei and F. Varasteh, 2016. Potential of Increasing the Vase Life and Improvement of some Physiological Characteristics of Alstroemeria Cut Flowers by Using Non-Harmful Compounds environmentally. Journal of Chemical Health Risks, 6(1): 1–8.

- Bagamboula, C.F., M. Uyttendaele, and J. Debevere, 2004. Inhibitory effect of thyme and basil essential oils, carvacrol, thymol, estragol, linalool and ρ -cimene towards *Shigella sonnei* and *S. flexneri*. *Food Microbiol.*, 21: 33-42.
- Banjaw, D. T., D.T. Lemma, and H.G. Megersa, 2017. Review on Effect of Essential Oil on Vase Life of Cut Flowers. *Journal of Biology, Agriculture and Healthcare*, 7(11):25-28.
- Bayat, H., R. Geimadil, and A.A. Saadabad, 2013. Treatment with Essential Oils Extends the Vase Life of Cut Flowers of Lisianthus (*Eustoma grandiflorum*). *Journal of Medicinal Plants and By-products*, 2: 163-169.
- Bidarigh, S., 2015. Improvement Vase Life of Chrysanthemum (*Dendranthema grandiflorum* L.) Cut Flowers Using Essential Oils of Geranium, Eucalyptus and Myrtus. *Journal of Ornamental Plants*, 5(4): 213-221.
- Blacquière, T., N. Straver, and D. van den Berg, 2002. Possibilities for using photoperiodism to program flowering of sunflowers (*Helianthus annuus*) in the greenhouse and in the open. *Acta Hort.*, 580:101-109.
- Burt, S., 2004. Essential oils: their antibacterial properties and potential applications in foods. *Int. J. Food Microbiol.*, 94: 223-253.
- Canakci, S., 2008. Effects of salicylic acid on fresh weight change, chlorophyll and protein amounts of radish (*Raphanus sativus* L.) seedlings. *J. Biol. Sci.*, Vol. 8, pp. 431-435.
- Carrubba, A. and C. Catalano, 2011. Cultivation of dill (*Anethum graveolens* L.) with different row arrangements. *Acta Horticulturae*, 925(925):205-211.
- Chaturvedi, R. and J. Shah, 2007. Salicylic acid in plant disease resistance. In Hayat S. Ahmad A (eds.) *Salicylic Acid – A Plant Hormone*, Springer, Dordrecht, The Netherlands, 335-370.
- Dashtbany, S., M. Hasemi, and D. Hashemabadi, 2015. Study on interaction effects of Mechanical and Geranium essential oil treatments on vase life of cut chrysanthemum (*Dendranthema grandiflorum* L. *J. Ornam. plants*, 5(2): 97-103.
- El-Sheshtawy, A.A., and R.S. El-Serafy, 2016. Improving the postharvest quality of chrysanthemum cut flowers by natural preservative solution. *Menoufia J. Plant Prod.*, 1: 113-123.
- Gebremedhin, H., B. Tesfaye, A. Mohammed, and D. Tsegay, 2013. Influence of preservative solutions on vase life and postharvest characteristics of rose (*Rosa hybrid*) cut flowers. *International Journal for Biotechnology and Molecular Biology Research* 4(8): 111-118.
- Hashemabadi, D., 2014. Response of Cut Carnation cv. Tempo to Essential Oils and Antimicrobial Compounds. *Journal of Agricultural Engineering and Food Technology*, 1(1): 1-6.
- Hatami, M., A. Hatamzadeh, M. Ghasemnezhad, and M. Ghorbanpour, 2013. The comparison of antimicrobial effects of silver nanoparticles (SNP) and silver nitrate (AgNO_3) to extend the vase life of 'Red Ribbon' cut rose flowers. *Trakia Journal of Sciences*, 2: 144-151.
- He, S., D.C. Joyce, D.E. Irving, and J.D. Faragher, 2006. Stem end blockage in cut Grevillea 'Crimson Yul-lo' inflorescences. *Postharvest Biol. Technol.*, 41: 78- 84.
- Heidarneshadian, H., B. Eghbali, and M. Kazemi, 2017. Postharvest life of cut gebera flowers as affected by salicylic acid and citric acid. *Trakia Journal of Science*, 15(1), 27-29.
- Herbert, D., P.J. Philipps, and R.E. Strange, 1971. Determination of Total Carbohydrates. *Methods in Microbiology*, 5: 290-344.
- Husia, C.L., B.S. Luh, and C.D. Chichester, 1965. Anthocyanin in free stone peaches. *J. Food Sci.*, 30: 5- 12.
- Jahanbazi, T., F. Mortezaiejad, and M. Jafararpour, 2014. Impact of salicylic acid and jasmonic acid on keeping quality of rose (cv. 'Angelina') flower. *Journal of Novel Applied Sciences*, 3 (11): 1328-1335.
- Jamshidi, M., R. Naderi, and E. Hadavi, 2012. Effects of Salicylic Acid and Malic Acid on vase life and bacterial and yeast populations of preservative solution in cut Gerbera flowers. *International Journal of AgriScience*, 2(8): 671-674.
- Jones, R. B., Serek, M. and Reid, M.S., 1993. Pulsing with Triton X-100 Improves Hydration and Vase Life of Cut Sunflowers (*Helianthus annuus* L.. *Hortscience*, 28(12): 1178–1 179.
- Kazemi, M., Abdossi, V., Kalateh Jari, S. and A.R. Ladan Moghadam, 2018. Effect of pre-and postharvest salicylic acid treatment on physio-chemical attributes in relation to the vase life of cut rose flowers. *The Journal of Horticultural Science and Biotechnology*, 93(1): 81-90.

- Kazemi, M., and A. Ameri, 2012. Response of vase life carnation cut flower to salicylic acid, silver nano-particles, glutamine and essential oil". *Asian Journal of Animal Science*, 6 (3): 122-131.
- Kazemi, M., M. Aran, and S. Zamani, 2011. Extending the Vase Life of *Lisianthus (Eustoma grandiflorum Mariachii. cv. blue)* with Different Preservatives. *American J. of Plant Physiology*, 6 (3): 167-175.
- Little, T.M. and F.J. Hills, 1978. *Agricultural Experimentation - Design and Analysis*. John Wiley and Sons, Inc., 53-60.
- Maneerung, T., S. Tokura, and R. Rujiravanit, 2008. Impregnation of silver nanoparticles into bacterial cellulose for antimicrobial wound dressing. *Carbohydrate Polymers*, 72 (1): 43-51.
- Marandi, R.J., A. Hassani, A. Abdollahi, and S. Hanafi, 2011. Improvement of the vase life of cut gladiolus flowers by essential oils, salicylic acid and silver thiosulfate. *J. Medicinal Plants Res.*, 5: 5039-5043.
- Marousky, F.J., 1969. Conditioning Gladiolus spikes to maintenance of fresh weight with pre-treatments of 8-hydroxy quinoline citrate plus sucrose. *Proc. Fla. State. Hort. Soc.*, 82:411-414.
- Nabigol, A., R. Naderi, M. Babalar, and M. Kafi, 2005. Increasing vase life of chrysanthemum cut flowers by using floral preservatives and recutting. *Iranian Society for Horticultural Science*, 7(4): 207-216.
- Navarro, E., A. Baun, R. Behra, N.B. Hartmann, J. Filser, and A.J. Miao, 2008. Environmental behavior and ecotoxicity of engineered nanoparticles to algae, plants, and fungi. *Ecotoxicology*, 17 (5): 372-386
- Patel, D.K., S.L. Chawla, and G.N. Vithu, 2018. Effect of Botanicals on vase life of cut flowers: A Review. *Bulletin of Environment, Pharmacology and Life Sciences*, 8 (1): 01-08.
- Saini, R.S., R. Yamdaqni, and S.K. Sharma, 1994. Influence of different pulsing and holding solutions on vase life of tuberose. *South Indian Horticulture*, 42: 376-378.
- Saric, M.R., T. Kastrori-Cupina, and I. Gergis, 1967. Chlorophyll determination Univ. Unoven Sadu-Praktikum is KiziologizeBilika-Beagrad, Haucua Anjiga., 215.
- Shanan, T.N., K.S. Emara, and S.O. Barakat, 2010. Prolonging vase life of carnation flowers using natural essential oils and its impact on microbial profile of vase solutions. *Australian Journal of Basic and Applied Sciences*, 4(8): 3559-3574.
- Singleton, V.L., R. Orthofer, and R.M. Lamuela-Raventos, 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Method. Enzymol.*, 299: 152-178.
- Solgi, M., M. Kafi, T.S. Taghavi, and R. Naderi, 2009. Essential oils and silver nanoparticles (SNP) as novel agents to extend vase-life of gerbera (*Gerbera jamesonii* cv. 'Dune') flowers. *Postharvest biology and technology*, 53(3): 155-158.
- Yuping, Z., 2009. Effects of salicylic acid on fresh keeping of cut *Gerbera jamesonii* flower. *Anhui Agricultural Science Bulletin*, 13
- Zamani, S., M. Kazemi, and M. Aran, 2011. Postharvest life of cut rose flowers as affected by salicylic acid and glutamin. *World Applied Sciences Journal*, 12(9): 1621-1624.