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EFFECT OF ESSENTIAL OILS ON STORAGE AND KEEPING QUALITY OF GLADIOLUS CUT FLOWERS

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ABSTRACT: A trial was consummated at Postharvest Lab. of Floriculture Res. Dept. Hort. Res. Inst. ARC, Giza, Egypt during 2019 and 2020 seasons to study the influence of essential oils of clove and sage oil in two experiments as preservative solutions, or a spray treatments as well as under long term of storage at low temperatures for three periods on quality and vase life of cut inflorescences of *Gladiolus grandiflorus*. In the first experiment five holding solutions included, clove oil at 1 and 2 mg/l + 20 g/l sucrose (suc.), sage oil at 1and 2 mg/l + 20 g/l sucrose (suc.), 8-hydroxyquinoline citrate (8-HQC) at 200 ppm + 20 g/l sucrose (suc.) and control (distilled water D.W.) were used. In second experiment that used essential oils as spray treatments. The obtained results from the two experiments indicated that, the flowers hold in the preservative solution of sucrose + clove oil (1 mg/l) significantly prolonged vase life, increased flowers fresh weight (%) and water uptake (g), dry weight (%), percentage of opening floret (%) and decreased water loss (g), bacterial counts in the vase solution. Essential oils had a positive effect on total sugar concentrations, level of total indoles and total phenols and total chlorophyll contents of cut flowers. Essential oils as an alternative substitute to chemical compounds had an excellent effect on cut flowers also because of their antimicrobial activities and environmental friendly nature.

Key words: *Gladiolus grandiflorus*, cut flowers, essential oils, preservative solutions, cold storage.

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) plant belongs to the family Iridaceae and is one of the leading cut flowers of world. It has been appropriately crowned as “Queen of Bulbous Flower”. The flowers are popular due to majestic spikes which comprise attractive, dazzling, elegant and delicate florets. The opening of florets of gladiolus in sequence over a longer duration makes it to be a very good quality of cut flowers. The gladiolus flowers are available in fantastic colour range and spikes of almost any colour near black to white, mauve, violet, pink, yellow and mixed of these colours are available. The qualitative and quantitative post-harvest losses of gladiolus quality can be reduced by select the improved technologies like harvesting at timely or appropriate stage, use of floral preservatives and bud opening solution, pre-cooling, pulsing, improved storage techniques such as suitable temperature storage, proper packaging methods etc. Use of floral preservatives is the most economical and practical methods to prolonged shelf life of gladiolus spikes (Gupta and Kumar, 2018).

Sugars in vase solutions prolong the shelf life of many cut flowers. Carbohydrates are the main substrates for respiration, which are essential for all living cells, and they are also a major structural material used in cell growth and enlargement and a soluble component in petal tissues, and hence an important osmotic regulator of water potential (Mayak *et al.*, 2001). Kumar *et al.*

(2008) stated that, sugar concentrations are still high when petals attain the early stages of senescence, due to various tissues in a petals are at different stages of senescence; sugar concentrations found in the cytoplasm and the vacuole are different and sugars are still formed or moved to petals.

Essential oils (EOs) are complex and highly variable mixtures of components that belong to two groups: aromatic and terpenoids compounds that accumulate in all types of vegetative organs (flowers, leaves, roots, rhizomes, fruits, bark, woods and seeds). In nature, essential oils play an important role to protect the plants as antifungal, antiviral, antibacterial and insecticides (Bakkali *et al*., 2008). The antimicrobial properties of essential oils have been known for a long time and documented in several studies (Marandi *et al.,* 2011). Also, EOs could consider as a good antioxidants. Besides, essential oils have great role in floriculture industry because of its environmental friendly properties and its antimicrobial properties in prolonging cut flowers freshness and post harvest durations. Commercial essential oils from plants are a mixture of several components; some of those components are found in clove, oregano, cinnamon, garlic, citral, parsley, coriander, rosemary, lemongrass and sage, all of those have been shown to express antimicrobial effects (Tajkarimi *et al*., 2010). Nassar *et al*. (2007) and Alma *et al*. (2007) found that, the major components of clove oil were eugenol (71.56%) and eugenol acetate (8.98%). Antimicrobial activity of eugenol is correlated to its ability to permeabilize the cell membrane and interact with proteins. The eugenol action on the cytoplasmic membrane has been confirmed in previous studies as it increased the transport of potassium and ATP out of the cells (Walsh *et al*., 2003; Gill and Holley, 2006 and Hemaiswarya and Doble, 2009). The chemical compound of eugenol contains hydroxyl group. Also, it is thought to bind to and affect the properties of proteins, thereby contributing to eugenol inhibitory effect at sub-lethal concentrations. Clove oil contains a large number of effective components and has very intense aroma and clove oil showed effects on improving digestion and inhibiting microorganism growth, which have been proved by modern pharmacological studies.

Many studies have shown that the essential oil of sage plant contains important free radical sensors such as saponins, alkaloids, phenolic and flavonoids compounds that may have a direct effect on ROS activity by trapping them or an indirect effect by increasing the production of intracellular antioxidant enzymes (Mbaye *et al.,* 2019). Sage was used in ancient Egyptian, Roman and Greek medicines. The ancient Egyptians used it as a fertility drug, while the Greeks used sage to stop bleeding of wounds and to clean sores and ulcers, towards cough and hoarseness, enhancing memory functions, for gargles to treat sore throats and mouths. Sage herb and oil is well known for carminative, antiseptic, astringent, antispasmodic and antihidrotic properties. Antioxidant properties of sage were found to be related with presence of rosmarinic acid, salvianolic acid, carnosic acid and its derivates (Karakaya *et al.,* 2011).

Cold storage of cut flowers encourage the adjustment of flowers and other planting material supplies against market demand and enables accumulation of large quantities (Senapati *et al.*, 2016). Temperature assumed is the most important factor affecting the quality and longevity of cut flowers and there a negative correlation observed between the increasing temperature and reduction of cut flower longevity under physiological temperatures, (Cevallos and Reid, 2000). Using low temperatures during storage are important for the conservation of these flowers in addition to inhibiting bacterial infections; it reduces ethylene production and degradation of certain enzymes. Boonyakiat (2005) have reported that, low temperatures could reduce the respiration rate and the carbohydrate consumption in addition to inducing a reduction in the sugar accumulation, whereas

high temperatures induce growth and development as well as senescence. Refrigerated storage of flowers is an influential process to preserve them during the periods of descent or drop in demand. Besides, storage is a considerable utility to hold the flowers days of rise or tip demand and also offers possibility to long term shipment. Short shelf life is one of the most paramount problems of the cut flowers. However, extending shelf life of cut flowers is an important factor in consumer preference.

The current work aims to examine the effects of essential oils (clove and sage) as preservative solutions, or spray treatments as well as under long term of storage at low temperatures for three periods on quality and vase life of cut inflorescences of *Gladiolus grandiflorus*.

MATERIALS AND METHODS

The present trial was undertaken at the Postharvest Laboratory of Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., Giza, Egypt during two successive seasons (2019 and 2020) to evaluate the response of gladiolus cut inflorescence to some postharvest treatments.

The fresh inflorescences (*Gladiolus grandiflorus*) were brought from local commercial farm (Al-Qanater Alkhayriuh) after picking up them in the early morning (in colored bud stage) with almost 3-5 leaves and quickly transported to the lab, then the leaves on the lower third of the stem were removed. In the Lab, the cut flowers were firstly pre-cooled to remove the field heat, selected for uniformity and the stem bases were re-cut under water to a length nearly 70 cm. The prepared cut flowers were divided to 4 groups, and then subjected to the following treatments in two independent experiments:

In the first experiment, the bases of inflorescence stems of the first group were hold in clear glass jars (3 stems/jar). The jars were filled with about 350 ml of one of the following preservative solutions:

1. Distilled water as control.
2. 8-HQC (8-Hydroxyquinoline citrate) at 200 ppm + sucrose at 20 g/l.
3. Clove oil at 1 mg/l + sucrose at 20 g/l.
4. Clove oil at 2 mg/l + sucrose at 20 g/l.
5. Sage oil at 1 mg/l + sucrose at 20 g/l.
6. Sage oil at 2 mg/l + sucrose at 20 g/l.

Tween-20 (0.1 ml/l) were used as a surfactant (wetting agents).

In the second experiment, the other three groups were subjected to cold storage for periods of 5, 10 and 15 days after spraying spikes with:

1. Distilled water (D.W.) as control.
2. 8-HQC (8-Hydroxyquinoline citrate) at 200 ppm.
3. Clove oil at 1 mg/l.
4. Clove oil at 2 mg/l.
5. Sage oil at 1 mg/l.
6. Sage oil at 2 mg/l.

Then, left them to dry in the laboratory atmospheric. Then the flowers were warped and packed in card bored boxes at 5 ℃.

The two experiments were carried out under ambient temperature 20±2 °C, 60±2 RH and 20 $\mu molm^{-2}s^{-1}$, light intensity under a daily light period of 12 h, then the cut flowers were placed individually in glass bottles (500 ml) with 350 ml of the experiment solution plus citric acid at 200 mg/l + sucrose at 20 g/l in second experiment.

Collected data were:

- Weight loss during cold storage (%): measure the lack of weight in cut spikes after storage periods.
- Vase life (days): the duration between the start of treatment until the senescence the third of stem of cut flowers in vase solutions.
- Water loss (g/inflorescence): cumulative the rate of water loss was recorded for the

entire period of vase life of the cut flowers.

- Solution uptake (g/inflorescence): solution uptake of vase solution was measured daily by weighing the vase solution.
- Relative fresh weight (%): the fresh weight of cut flowers was recorded daily in 1, 3, ... etc. during the experiment in both seasons. Relative fresh weight of cut stems of flowers was calculated using the following formula:

$$RFW\ (\%) = \frac{\text{Fresh weight of stem in mentioned day}}{\text{Fresh weight of stem in zero day}} \times 100$$

- Floret opening (%): the total numbers of florets on each spike have listed on the day of harvest and the total numbers of fully opened florets on each spike have counted flowers.

$$\text{Percent of opened florets/spike} = \frac{\text{Number of opened flowers/spikes}}{\text{Total number of flowers/spikes}}$$

- Dry weight percentage of cut flowers (%): At the end of flower vase life, fresh weight of flower of each treatment was calculated and then dried to a constant weight in an oven for 24 h at 72 °C.
- Determination of microbial count: bacterial counts in the vase solution (log^{10} CFU ml^{-1}) according to De Witte and Van Doorn (1988).

Chemical analyses:

- Chlorophyll a and b and carotenoids (mg/g f.w.) in leaves, according to Saric *et al.* (1976).
- Total indoles (g/100 g), according to A.O.A.C. (1990).
- Total phenols (%), according to A.O.A.C. (1990).
- The total sugars and reducing sugars (mg/g dry weight), according to Smith *et al.* (1956).

Data were grouped and statistically analyzed according to SAS Institute program (2009) followed by Duncan's New Multiple Range Test (Steel and Torrie, 1980) to verify the significance among means of different treatments. The objective of this study project is to determine whether plant essential oils can be used as an antibacterial agent to eliminate microorganisms.

RESULTS AND DISCUSSION

The first experiment:

Vase Life (days):

Regarding to the effect of holding solutions of essential oils (EOs) treatments, that include clove and sage oils as well 8-Hydroxyquinoline citrate on vase life, data presented in Table (1) showed that, all treatments increased vase life of *Gladiolus grandiflorus* and clove oil at 1 mg/l + sucrose at 20 g/l under room temperature was the best treatment prolonged the cut fresh inflorescences vase life (17.33 and

Table 1. The effect of essential oils treatments on vase life (day), water uptake (g/inflorescence) and water loss (g/inflorescence) of gladiolus cut flowers during the two seasons 2019 and 2020.

Treatments	Vase life		Water uptake		Water loss	
	First season	Second season	First season	Second season	First season	Second season
Distilled water	9.67e	10.33f	62.99f	78.48f	116.3b	126.8b
HQC at 200 ppm + sucrose at 20 g/l	11.67d	12.33e	79.05d	89.56d	121.0a	128.2a
Clove oil at 1 mg/l + sucrose at 20 g/l	17.33a	18.33a	98.29a	111.5a	36.37c	42.69c
Clove oil at 2 mg/l + sucrose at 20 g/l	16.33b	17.33b	89.08b	104.6b	31.98e	36.71e
Sage oil at 1 mg/l + sucrose at 20 g/l	15.67b	16.33c	84.50c	82.93e	34.59d	38.30d
Sage oil at 2 mg/l + sucrose at 20 g/l	14.33c	14.67d	76.30e	99.35c	28.01f	35.51f

18.33 days) compared to control (9.67 and 10.33 days) in the first and second seasons, respectively. These results are in accordance with those reported by Shanan *et al*. (2010) who found that, the maximum vase-span over the two seasons was recorded with dill oil followed by coriander in *Dianthus caryphyllus*. El-Hanafi (2007) showed that, applying different essential oils to vase solution reduced the pH and prolonged of cut flowers vase life. The remarkable acidity of the vase solution in the presence of oils may be attributed to some of their acidic components in vase solution and acidic pH in petal sap which is associated with better viability of petals.

Water uptake (g/inflorescence):

It is evident from data presented in Table (1) that all holding solutions used in this study raised the amount of water up taken by flowering stems throughout vase period with various significant differences as compared to the amount up taken by flowering stems ranked in D.W. in the two seasons. The excellence was for clove oil at 1 mg/l + sucrose at 20 g/l that recorded the utmost high values of water uptake in both seasons (98.29 and 111 g/inflorescence) comparison with the rest of the transactions under trial. Antibacterial activity of plant essential oils can be refer to the chemical constituents and functional groups present in plant essential oils, the proportions in which they are present, and the interactions between them (Dorman and Deans 2000), then the antibacterial agents (EOs) that will keep the solution free from most of microorganisms and can form occlusion inside the stem obstructing the flow of solution to the flower. These effects of essential oils agreed with the finding of Solgi *et al*. (2009) who revealed that treatment with essential oils had significant effect on the solution uptake, fresh weight and vase life cut gerbera 'Dune'.

Water loss (g/inflorescence):

Data presented in Table (1) illustrated that water loss of cut stems was the highest in flowers treated with HQC at 200 ppm + sucrose at 20 g/l followed by distilled water as control treatment. Using sage oil at 2 mg/l + sucrose at 20 g/l that may be attributed to the fact that the availability of more sugars could increase the respiration rate thereby leading to excess water loss through transpiration. Transpiration loss appeared when water moves unhindered through xylem vessels. Essential oils help in reducing the microbial growth in xylem vessels thus enhancing the water uptake and subsequent transpiration loss through flowers. Similar results were also found in a previous study by Gani *et al.* (2018) on cut carnation.

Relative fresh weight (%):

According to the data presented in Table (2), it can be concluded that, all holding solutions caused a positive increment compared to holding in D.W. in both seasons. Treated cut stems of gladiolus with clove oil at 1 mg/l with sucrose at 20 g/l gave a reduction in fresh weight loss, that

Table 2. The effect of essential oils treatments on relative fresh weight (%), floret opening (%) and dry weight (%) of gladiolus cut flowers during the two seasons 2019 and 2020.

Treatments	Relative fresh weight		Floret opening		Dry weight	
	First season	Second season	First season	Second season	First season	Second season
Distilled water	87.08d	93.10f	45.49f	48.06f	10.27e	11.41f
HQC at 200 ppm + sucrose at 20 g/l	93.01c	103.1d	55.60e	56.66e	12.58d	12.96e
Clove oil at 1 mg/l + sucrose at 20 g/l	122.0a	132.2a	92.68a	92.13a	16.44a	17.54a
Clove oil at 2 mg/l + sucrose at 20 g/l	99.86b	107.0b	84.93b	86.26b	15.19b	16.19b
Sage oil at 1 mg/l + sucrose at 20 g/l	99.61b	104.5c	76.48c	73.27c	15.45b	15.82c
Sage oil at 2 mg/l + sucrose at 20 g/l	93.01c	99.44e	65.70d	72.13d	13.75c	14.76d

could be the result of the anti-microbial property of clove oil in reducing the microbial proliferation which may be helps in improving water balance and increasing the amount of water uptake, which reflected on increasing of fresh weight of cut flowers. These results are in agreement with the findings of Kazaz *et al*. (2020) they pointed out that, thymol treatment at 150 mg/l with 1% sucrose significantly delayed relative fresh weight loss.

Floret opening (%):

Data in Table (2) showed marked differences in floret opening (%) of *Gladiolus grandiflorus.* when subjected to the different treatments. The data cleared that all treatments increased opening percentage of gladiolus flowers with superiority for the treatment of clove oil at 1 mg/l. with sucrose at 20 g/l, as it gave almost double that percentage of opening florets which obtained from cut flowers treated with distilled water. The results are in a parallel line with those of Zaky and Amin (2013) who stated that, dipping cut calla flowers in 1 ml/l anise and eucalyptus oils increased significantly the percentage of flower opening also, Zaky and El Zayat (2008) observed that dipping cut carnation flowers in jasmine oil solution at (0.015 and 0.030%) for one hour were most effective on increasing the percentage of flower opening.

Dry weight (%):

As shown in Table (2) a higher dry weight of cut flowers was maintained in spikes which placed in clove oil at 1 mg/l + 20 g/l sucrose than those of the control. Relevant values for the maximum increase in the dry weight were 16.44% and17.54% in the first and second seasons, respectively. However, the lowest values of this parameter accompanied the control, which were 10.27% and 11.41% during vase life. The application of clove oil increased dry weight percentage as well as the percentage of fresh weight in cut spikes of gladiolus.

Bacterial counts in the vase solution (log^{10} CFU/ ml):

Change in bacterial number (Table, 3) showed that, growth inhibition impact on bacteria by applying essential oils during both seasons. The control treatment containing distilled water harbored the highest bacterial population densities (11.4and 10.8) in both seasons compared with those of 8-HQC (4.6 and 3.9) and the other examined oils. Treating with clove oil at the two levels (1and 2 mg/l) appeared a superior antibacterial substance causing highly reduction in the average log count of total bacteria compared to the control of the experiment. The anti microorganisms properties of 8-HQC as well as the different essential oils and their protective effects on cut flowers of carnation in the vase solution were previously documented (Kushal *et al*., 2003 b and El Hanafi, 2007). A vast array of available reports on anti microorganisms activities of the examined essential oils showed possible implications of such natural phyto-chemicals in vase solutions disinfection purposes (Lo Cantore *et al*., 2004 and Saeed and Tariq, 2007). In this regard, Babu *et al*. (2011) stated that, essential oil of clove was also found to be

Table 3. The effect of essential oils treatments on bacterial counts (log^{10} CFU/ ml). of gladiolus cut flowers during the two seasons 2019 and 2020.

Treatments	First season	Second season
Distilled water	11.4	10.8
HQC at 200 ppm + sucrose at 20 g/l	4.60	3.90
Clove oil at 1 mg/l + sucrose at 20 g/l	1.00	1.00
Clove oil at 2 mg/l + sucrose at 20 g/l	1.10	1.00
Sage oil at 1 mg/l + sucrose at 20 g/l	3.00	2.60
Sage oil at 2 mg/l + sucrose at 20 g/l	2.00	1.80

highly effective against *Campylobacter jejuni* followed by *Escherichia coli* and *Staphylococcus aureus*. *Listeria monocytogenes* and *Methicillin resistant S. aureus* were comparatively less sensitive to the action of essential oil of clove.

Chemical analyses:

Data presented in Tables (4 and 5) indicated that, essential oils treatments had positive effects on leaf content of photosynetic pigments in the leaves (chlorophylls a and b, total chlorophylls and carotenoids). Treating cut flowers with clove oil gave the highest means of the previous pigments as compared to the control. Several reports are also in accordance with the previous gains, such as those of Aziz *et al.* (2020) who postulated that, clove oil increased the chlorophyll content in some lily cvs. "Zambesi", "Sorbonne", and "Caesars". Similarly, Teerarak *et al.* (2019) established that, the application of essential oils such as ginger oil decreased the retardation of chlorophyll (both a and b), lowered the accumulation of malondialdehyde and enhanced the scavenging activities. The great role of essential oils in enhancing photosynthetic pigments, may be attributed to the antioxidant properties of essential oils in maintenance of chlorophylls. The increase in chlorophylls is because of cells activity and increasing the production of sugars, that decreases chlorophyll loss by regulating the osmotic pressure and respiratory rate (Andersen *et al.*, 2004). Values varied between parameters in total indoles and total phenols. On the other hand, control treatment gave the least value in total sugars percentage in leaves and flowers compared to the other treatments. Clove oil gave the maximum amount of total sugars in leaves of cut gladiolus.

The second experiment:

Weight loss during cold storage:

Regarding the effect of storage periods on weight loss of cut spikes of gladiolus as shown in Table (6), it was noticed that

Table 4. The effect of essential oils treatments on chlorophylls and carotenoids (mg/g f.w.), total indoles (g/100 g) and total phenols (%) content of gladiolus cut flowers and leaves.

Treatments	Chlorophyll				In flowers		In leaves	
	Chl. a	Chl. b	Chl. a + b	Caro.	Total indoles	Total phenols	Total indoles	Total phenols
Distilled water	0.510	0.344	0.854	1.459	0.481	3.955	0.822	3.160
8-HQC at 200 ppm + sucrose at 20	1.075	0.117	1.193	1.874	0.484	3.663	0.837	2.965
Clove oil at 1 mg/l + sucrose at 20 g/l	1.091	0.502	1.893	4.213	0.493	3.124	0.863	3.057
Clove oil at 2 mg/l + sucrose at 20 g/l	0.971	0.513	1.484	2.302	0.556	3.118	0.824	2.720
Sage oil at 1 mg/l + sucrose at 20 g/l	1.527	0.349	1.876	2.519	0.511	3.153	0.971	2.736
Sage oil at 2 mg/l + sucrose at 20 g/l	0.556	0.176	0.732	2.689	0.521	3.100	0.926	3.030

Table 5. The effect of essential oils treatments on total sugars (mg/g d.w.), reducing and non-reducing sugars (mg/g d.w.) of gladiolus cut flowers and leaves.

Treatments	In leaves			In flowers		
	Total sugars	Reducing sugars	Non-reducing sugars	Total sugars	Reducing sugars	Non-reducing sugars
Distilled water	41.00	8.05	32.95	27.025	7.18	19.84
8-HQC at 200 ppm + sucrose at 20	51.12	10.14	40.98	30.757	12.52	18.23
Clove oil at 1 mg/l + sucrose at 20 g/l	55.14	9.54	45.60	34.536	8.04	26.49
Clove oil at 2 mg/l + sucrose at 20 g/l	54.17	8.51	45.66	33.456	8.91	24.54
Sage oil at 1 mg/l + sucrose at 20 g/l	48.01	10.46	37.55	35.695	13.96	21.73
Sage oil at 2 mg/l + sucrose at 20 g/l	56.72	10.69	46.03	33.247	8.98	24.26

Table 6. The effect of essential oils treatments on weight loss (%) of gladiolus cut flowers under cold storage conditions during the two seasons 2019 and 2020.

Treatments	Cold storage							
	5 days	10days	15 days	Mean	5 days	10 days	15 days	Mean
	Weight loss							
	First season				Second season			
Distilled water	2.41 b	2.30bc	2.83 a	2.51a	2.34bc	2.45b	2.85a	2.55 a
HQC at 200 ppm	1.12 h	2.00de	2.23bc	1.78b	1.15g	2.10ce	2.25bc	1.83 b
Clove oil at 1 mg/l	0.78 j	1.72 g	2.21bc	1.57c	0.86h	1.74 f	2.18b-d	1.59 d
Clove oil at 2 mg/l	0.87 ij	1.74 g	2.11cd	1.57c	0.96fg	1.81 f	2.20b-d	1.66cd
Sage oil at 1 mg/l	1.05hi	1.86eg	2.29bc	1.73b	1.10gh	1.89ef	2.28bc	1.76bc
Sage oil at 2 mg/l	1.10 h	1.94 df	2.33 b	1.79b	1.17g	1.98df	2.29bc	1.81 b
Mean	1.22c	1.93 b	2.33 a		1.26 c	2.00b	2.34 a	

storage period for fifteen days had the maximum reduction of weight during storage in comparison with the rest of the transactions, which achieved 2.33% and 2.34%, while storage in five and ten days were (1.22 and 1.26%) and (1.93 and 2.0 %) in the first and second seasons, respectively. As the storage period increases, the quality of stored cut flower decreases, this may be attributed to the adverse effects of prolonging cold storage on postharvest quality and water loss which accounts for the physiological loss in weight was less when cut flowers were stored in lower temperature due to vapor pressure deficit was smaller at short time of storage while in long term of cold storage thereby causing less moisture as well as weight loss. This result corresponds to Zencirkiran and Mengüç (2003) on alstroemeria "Ostara" cut flowers who found that, the respiration rate generally decreased during postharvest storage, and weight loss increased relation to the length of storage duration. Kushal *et al.* (2003, a) showed that, an increasing in percent weight loss on gladiolus with increasing storage period. Ranwala and Miller (2005) found that, cold storage caused several adverse effects on postharvest quality, including accelerated leaf yellowing or browning and reduced flower or inflorescence longevity. Cut spikes of gladiolus response differed to the treatments, with the effect of storage conditions and periods it has been observed that distilled water gave the highest values in this concern. Clove oil at the two concentrations used, gave the lowest values of weight loss (at the first and second seasons) which confirms the effectiveness of treatment with essential oils on the cut flowers.

Vase Life (days):

From data averaged in Table (7) it is clear that all holding solutions contain essential oils of clove and sage used in this study prolonged the vase life of cut spikes of gladiolus with significant differences in the two seasons compared to holding either in D.W. or in 8-HQC. Moreover, the combined treatment of clove oil + sucrose, was the best and the most effective in increasing the survival time of the gladiolus cut flowers in the vase, compared to the rest of the transactions, as each of them plays an important role prolonging vase life for cut flowers; sucrose provides flowers with energy necessary for fundamental cellular processes also it can effectively maintain the integrity of the structure of cut flowers, whereas clove oil is an antimicrobial agent while inhibits the action and activity of microorganisms and so they improve the vase life of cut flowers through delaying its senescence. Generally, non chemical alternatives such essential oils are being applied by many authors for prolonging vase life of many cut flowers (Hashemabadi *et al*., 2013; Bazaz *et al*., 2015 and Bidarigh, 2015). Also, Mirdehghan *et al.* (2016) studied the activity of essential oils in extending the cut flowers vase life,

Table 7. The effect of essential oils treatments on vase life(days) and relative fresh weight (%) of gladiolus cut flowers under cold storage conditions during the two seasons 2019 and 2020.

Treatments	Cold storage							
	5 days	10 days	15 days	Mean	5 days	10 days	15 days	Mean
	Vase life							
	First season				Second season			
Distilled water	9.33hi	9.00i	7.00j	8.44d	9.67h	9.33h	7.33j	8.78d
HQC at 200 ppm	11.00fg	11.00fg	9.33hi	10.44c	12.00ef	11.33fg	10.00h	11.11c
Clove oil at 1 mg/l	16.67a	12.67ed	11.00fg	13.44a	17.67a	13.33d	12.00ef	14.33a
Clove oil at 2 mg/l	14.33b	14.67b	10.33gh	13.11a	14.33e	15.00be	11.33fg	13.56b
Sage oil at 1 mg/l	15.33b	12.33e-c	11.67d-f	13.11a	15.33b	12.33d-f	12.67de	13.44b
Sage oil at 2 mg/l	13.00c	11.33e-g	9.67hi	11.33b	13.00de	11.33fg	10.33gh	11.56c
Mean	13.28a	11.83b	9.83c		13.67a	12.11b	10.61c	
	Relative fresh weight							
Distilled water	105.87 d	75.27m	80.03l	87.06c	121.64e	86.68jk	80.40l	96.24 e
HQC at 200 ppm	119.13b	86.73i	80.63kl	95.50b	130.77d	100.25h	84.83k	105.29d
Clove oil at 1 mg/l	126.89a	99.48e	83.25j	103.21a	139.65b	113.87f	90.79i	114.77a
Clove oil at 2 mg/l	120.48b	95.40f	89.95h	101.95a	135.39c	100.46h	98.61h	111.49b
Sage oil at 1 mg/l	128.46a	95.70f	81.53j-l	101.90a	147.06a	107.24g	91.44i	115.25a
Sage oil at 2 mg/l	114.41e	92.76g	82.96jk	96.71b	133.55c	100.33h	88.07j	107.32c
Mean	119.21a	90.89b	83.06c		134.68a	101.47b	89.02c	

and determined that addition of 2, 4 and 6 mg/l of EOs of savory, 2 mg/l of ajowan and 2 mg/l of thyme, to preservative solutions could extend significantly the vase-life of gladiolus compared to control. Besides, the essential oils (EOs) are natural antioxidant substances, could help cells to stand against free radicals and protect them and other macromolecules (e.g. photosynthetic pigments, proteins and lipids) from the influence of free radicals, thereby delaying leaf senescence.

As for the storage effect, the results confirm that the superfluous storage led to a negative impact on vase life causing reduction via first and second seasons. Bayleyegn *et al.* (2012) stated that, long periods of storage ultimately had negative effects on the ultimate vase life of the cut rose flowers. Walton *et al.* (2010) found that, the vase life of fresh peonies extended 5 days longer than that of flowers stored for 8 weeks. On the other side, data in Table (5) indicate that holding in clove oil at 1 mg/l + sugar at 20 g/l under cold storage for 5 days gave the maximum vase life (16.67 and 17.67 days in the first and second seasons, respectively) in comparison with all used transactions especially with the vase life of control which was (7.00 and 7.33days, respectively) under 15 days cold storage in two seasons.

Relative fresh weight (%):

Data illustrated in Table (7) showed that, all holding solutions caused a positive increment in relative fresh weight compared to the control treatment (D.W.) in both seasons. The highest reduction percentages of the flower fresh weight over the two seasons were 87.06 and 96.24% recorded in control treatment. On the other hand, the corresponding values in clove oil at 1 mg/l, clove oil at 2 mg/l, and sage oil at 1 mg/l were (103.21, 101.95 and 101.90% in the first season) and (114.77, 111.49 and 115.25% in the second season) which were the highest percentages in increasing relative fresh weight during current study. It was observed that most of the essential oil treatments showed similar effects. The influence of oils on improving fresh weight is due to the presence of phenolic

compounds (important antioxidant compounds), and protecting from the membrane leakage and maintain fresh weight. Analogously observations were also elicited by Solgi *et al*. (2009) showed that, treatment with essential oils (thymol, carvacrol, garden thyme) had a significant effect in maintaining the fresh weight and prolonging vase life cut gerbera "Dune". Moreover, the impact of extract of ajowan oil had a beneficial effect on fresh weight (%) and vase life of cut gladiolus (Marandi *et al*., 2011). Bayat *et al*. (2013) mentioned that, different preservatives containing essential oil showed positive effects on both relative fresh weight and freshness of flower.

With regard to the effect of storage periods on weight it was noted that there was decrease in relative fresh weight with the increase in storage periods, due to flower transpiration decreased the capacity of flowers to absorb water from solutions or both during storage periods. Similar results were reported by Jain *et al.* (2007) on rose and Varu and Barad (2008) on tuberose. In the same Table (7) data clarify that, cold storage before holding was found to induce a negative effect on vase life of gladiolus inflorescences. The treatment with sage oil + storage conditions for five days achieved superiority compared to the control and other treatments, also, sage oil at 1 mg/l combined with sucrose at 20 g/l gave 128.46 and147.06% in the first and second seasons, respectively. It was showed superior results as reported by Gani *et al.* (2018) they found that, sage oil gave higher fresh weight than control (distilled water), due to the beneficial effect of essential oils could be related to their antioxidants activity and also to their antimicrobial properties. In corresponds to this opinion, Gomes *et al.* (2002) mentioned that, sage is one of the strongest antioxidants among medicinal herbs, which is reflected on the maintenance turgidity of cut flowers as well as fresh weight of cut flowers.

Water uptake (g/inflorescence):

By the perusing of the data in the Table (8) it is clear that, all preservatives solutions used in this experiment raised the amount of water up taken by flowering stems

Table 8. The effect of essential oils treatments on water uptake (g/inflorescence) and water loss (g/inflorescence) of gladiolus cut flowers under cold storage conditions during the two seasons 2019 and 2020.

Treatments	Cold storage							
	5 days	10 days	15 days	Mean	5 days	10 days	15 days	Mean
	Water uptake							
	First season				Second season			
Distilled water	41.46k	50.03i	37.29l	42.93d	64.05ed	52.38i	47.28j	54.57e
HQC at 200 ppm	54.94ef	50.49hi	49.77i	51.74c	59.22fg	52.42i	55.46h	55.70d
Clove oil at 1 mg/l	85.16a	58.13d	53.48fg	65.59a	88.34a	61.21ef	62.22de	70.59a
Clove oil at 2 mg/l	60.65c	59.37cd	49.33i	56.45b	75.85b	62.43de	61.17ef	66.48b
Sage oil at 1 mg/l	81.91b	55.81e	57.93d	65.22a	87.83a	58.45g	64.82c	70.37a
Sage oil at 2 mg/l	58.97cd	52.40gh	45.57j	52.31c	74.16b	56.12h	55.51h	61.93c
Mean	63.85a	54.37b	48.90c		74.91a	57.17b	57.74b	
	Water loss							
Distilled water	50.67h	60.48f	94.91b	68.69b	59.88f	67.12e	113.99b	80.33a
HQC at 200 ppm	50.00h	53.47g	107.29a	70.26a	55.79g	66.75e	121.48a	81.44a
Clove oil at 1 mg/l	46.52ij	45.29j	69.74d	53.85f	48.55i	48.42i	93.08d	63.35d
Clove oil at 2 mg/l	46.36ij	50.44h	84.75c	60.52d	48.23i	52.83h	109.20c	70.09c
Sage oil at 1 mg/l	64.31e	41.95k	68.66d	58.31e	50.51hi	43.94j	94.59d	63.02d
Sage oil at 2 mg/l	48.98hi	51.13gh	86.62c	62.24c	52.07h	56.44g	111.27c	73.26b
Mean	51.14b	50.46b	85.33a		52.51c	55.92b	107.3a	

throughout the vase period as compared to the amount that in control, in the both seasons. Generally, using essential oils led to tremendous results as the maximum water uptake values (65.59 and 65.22 g) and (70.59 and 70.37 g) were recorded in flowers kept in clove oil at 1 mg/l and sage oil at 1 mg/l) in both seasons respectively. On the contrary the lowest cumulative water uptake (42.93 and 54.57 g) was recorded in the control. This may be attributed to the role of essential oils in the presence of sucrose on vase solution, the sucrose in vase life treatment had a positive effect on the mechanical rigidity of the stem and could induce cell wall thickening and lignification of vascular tissue as reported by Jafarpour *et al*. (2015). As for essential oils (such as sage and clove oils) they contain a wide variety of secondary metabolites that are suppressing the growth of microorganisms via membrane and cytoplasm. The aforementioned results are in well agreement with those manifested by Gani *et al.* (2018) who decided that, essential oils exhibit inhibitory effect on uptake of oxygen and oxidative phosphorylation of pathogens, which causing disturbance in cytoplasmic membrane, active coagulation of cell contents, disrupting proton motive force and thus release energy depletion which in turn improves water uptake. Moreover, in *Antirrhinum majus*, sugar was most effective when applied to vase solutions in combination with a biocide to inhabit the growth of microorganisms in xylem vessels and maintain water uptake, thus prolonging the longevity of cut flowers (Asrar,2012). In relation to the interaction treatments, data in Table (8), reveal that cut flower spry with clove improved the solution uptake and gave great values compared to all treatments under less storage period in this study.

Water loss (g/inflorescence):

According to data presented in Table (8), flowers treated with clove oil at 1 mg/l as spray then held to vase solution containing citric acid at 200 mg/l with sucrose at 20 g/l had lower rate of water loss and gave 53.85 - 63.35 g compared to 68.69 - 80.33 g in the control treatment with significant differences in the two seasons. On the other hand, data in the same Table indicated that treatment with sage oil at 1mg/l was the most effective on decreasing water loss compared with the control and the other holding solutions throughout holding cut flower stems in vase solution, and to be close to the effect of clove oil treatment in both seasons. Likewise, Shanan (2012) indicated that, essential oils increased the water uptake by reducing both transpiration rate and water loss, which increased vase life of rose cut flower. Also, this reduction in water loss may imply that sucrose induces the closure of stomata, eventually reducing the loss of water, thereby reducing transpiration. Many workers also reported a significant positive role of sugars on cut flowers; Possiel (2008) cleared that, carbohydrates acting as osmolytes, decreased water loss. An increasing pattern was observed afterwards from the beginning of storage for five days till the end of storage for two weeks in life span after storage during two seasons. The data concerning the effect of preservatives solutions and storage periods and their interaction on water uptake are presented in Table (8). In relation to the interaction treatments, these data reveal that spray with sage oil at1 mg/l was more effective in reduction loss of water in cut gladiolus compared to other treatments.

Floret opening (%):

The results in Table (9) showed that, all the used materials (included HQC at 200 ppm., clove oil at 1 mg/l, 2 mg/l and sage oil at 1 mg/l, 2 mg/l with vase solution containing citric at 200 mg/l + sucrose at 20 g/l) led to increase the percent of the fully opened florets per inflorescence of cut gladiolus spikes compared with the control treatment which had the lowest percent of the opened florets in both seasons. The highest percentage resulted from the transaction with clove oils at two concentrations in both seasons under this experiment. Positive response to essential oil

Table 9. The effect of essential oils treatments on floret opening (%) and dry weight (%) of gladiolus cut flowers under cold storage conditions during the two seasons 2019 and 2020.

Treatments	Cold storage							
	5 days	10 days	15 days	Mean	5 days	10 days	15 days	Mean
	Floret opening							
	First season				Second season			
Distilled water	37.19m	34.16 n	25.56o	32.3f	36.73k	33.58l	24.86m	31.72 e
HQC at 200 ppm	52.31j	47.31k	41.08i	46.90e	51.82h	47.76i	41.84j	47.14d
Clove oil at 1 mg/l	87.10a	75.15b	65.97e	76.08a	59.67g	75.59ab	66.37e	67.21b
Clove oil at 2 mg/l	74.60h	75.32b	64.5f	71.49b	74.43b	76.05a	65.75e	72.08a
Sage oil at 1 mg/l	72.69e	69.11d	68.88d	70.02c	74.68b	71.10c	68.95d	71.58a
Sage oil at 2 mg/l	61.18h	57.00i	63.10g	60.43d	63.68f	58.51g	62.41f	61.52c
Mean	64.18a	59.68b	54.85c		60.16a	60.43a	55.03b	
	Dry weight							
Distilled water	14.08g-i	15.44d-g	11.62j	13.72c	15.63h	17.17eg	14.24i	15.68 c
HQC at 200 ppm	14.49f-h	15.77d-f	12.86ij	14.37c	16.92gh	17.90de	15.74h	16.55b
Clove oil at 1 mg/l	13.85hi	19.80a	16.31c-e	16.65a	16.41f-h	21.34a	17.96de	18.57a
Clove oil at 2 mg/l	15.17d-g	17.48bc	17.92b	16.80a	16.28f-h	20.57ab	17.48df	18.11a
Sage oil at 1 mg/l	15.06d-g	17.57bc	15.75d-f	16.13a	18.41de	19.68bc	17.21eg	18.43a
Sage oil at 2 mg/l	14.93e-g	16.46cd	14.60f-h	15.33b	16.29d-g	18.65cd	16.55fh	17.16b
Mean	14.60b	17.09a	14.85b		16.51b	19.22a	16.53b	

addition to vase solution of cut flower water up take, relative fresh weight and freshness has been reported (Bayat *et al*., 2013). Whereas, Zaky and Amin (2013) observed that, dipping cut calla flowers in 1 ml/l anise and eucalyptus oils increased significantly the percentage of flower opening. Sucrose as a respiratory substrate and as an osmolite maintained the water balance, increased number of open buds, bud opening speed, improved color of petals and extended longevity of cut flowers. (Bosma and Reid, 2002 and Kumar and Deen, 2017).

Dry weight (%):

It can be concluded from Table (9) that all treatments significantly enhanced the percentage of dry matter and the clove oil at both concentrations as well as sage oil at 1 mg/l achieved great values compared to control (distilled water) due to the positive effect of essential oils on cut flowers. The findings were in parallel with that obtained by Basiri *et al*. (2011) who found that, enhancing dry matter by using antimicrobial agent. Blankenship and Dole (2003) noticed that, there is positive impact of essential oils and 8-HQC on dry matter percent and attributed this to their antimicrobial properties and the decrease rate of respiration.

Bacterial counts in the vase solution (log^{10} CFU ml^{-1}):

The highest microbial count was recorded in control, whereas, the lowest one was recorded in cut flowers treated with clove oil at 1 mg/l as spray and held in biocide solution contain citric acid at 200 mg/l + sucrose at 20 g/l, with consideration, all treatments gave better results than control and clearly reduced the number of bacteria in the vase solution (Table, 10). The oil of clove gave a excellence result and inhabited microorganisms in vase solution that may be attributed to its components mostly of eugenol, which is responsible for the antimicrobial activity of the oil, since it has the capacity to penetrate the cytoplasmic membrane of the microorganisms thereby increasing the non-specific permeability of the same, which can cause the rupture of membrane and microbial death. These findings agreed with the findings of Affonso

Table 10. Effect of essential oils treatments and storage period on bacterial counts (log^{10} CFU ml^{-1}) on solution vase life of gladiolus cut flowers at the end of longevity.

Treatments	Cold storage		
	5 days storage	10 days storage	15 days storage
Distilled water	6.0	9.2	12.0
HQC at 200 ppm	4.6	6.4	7.5
Clove oil at 1 mg/l	2.3	4.8	5.6
Clove oil at 2 mg/l	3.6	4.6	5.5
Sage oil at 1 mg/l	3.8	5.8	6.7
Sage oil at 2 mg/l	4.2	5.6	6.6

et al. (2012) and Mekinić *et al.* (2014) who determined the highest content of total phenolics and non-flavonoids in the sage extract, and it showed the best antibacterial activity, especially against gram-positive bacteria and *E. coli.* Generally, essential oil components attack the cell wall and react with enzymes responsible for synthesis of cell wall can be causing pathogen death. Moreover, the antibacterial properties of essential oils due to their lipophilic character that accumulate in bacterial membranes causing energy depletion. In many scientific researches, antimicrobial properties of essential oils were related to their phenolic and non-phenolic compounds which showed strongest inhibitory effects, followed by ketones and aldehydes. The monoterpene hydrocarbons were less active and it has been found that this behavior depends on the free hydroxyl group from the alcohols. These constituents affect cell membrane permeability, and able to disintegrate the outer membrane of gram-negative bacteria and increasing the permeability of the cytoplasmic membrane to ATP.

The mechanism of action is considered to be the disturbance of the cytoplasmic membrane, disrupting the proton motive force, active transport, electron flow, and coagulation of cell contents (Kotzekidou *et al.,* 2008 and Sharma and Tripathi, 2008). As for interaction treatments, prolonged storage (stored cut flowers of gladiolus for 15 days) of cut flowers has been found to have adverse effect on cut flowers, probably due to microbial proliferation.

Chemical analyses:

Data illustrated in Tables (from 11 to 13), demonstrate that, almost all preservative solutions decreased the degradation of chlorophyll and preserved total chlorophyll content compared with the control. Data proved that the most significant increase in chlorophyll content than other treatments was recorded the treatment of clove oil (especially at low dose 1 mg/l) followed by the other concentration of clove oil at 2 mg/l. The current study revealed that the change in chlorophyll content of gladiolus cut flowers was decreased with increasing storage periods. This may be reasonable because of the roles of essential oil which, partially prevent the impact of ethylene as confirmed by Prabha *et al.* (2018) who indicated that, essential oils reduced ethylene production in cut flowers. Consequently, treated cut flowers with clove and sage oils may inhibit ACC-oxidase activity that is the direct precursor of ethylene and decrease ROS (reactive oxygen species) with increase enzyme antioxidant activity and decrease the number of bacteria. In relation to the effect of essential oils treatments on total indoles and total phenols of gladiolus cut flowers, data recorded data in Tables (12 and 13) showed that, the level of total indole content generally increased with treating cut flowers with sage oil and then held in vase solution contain biocide (citric acid) with sucrose giving a slight increase compared with control and other treatments. A similar trend was obtained regarding the effect of holding solutions accomplished in the current study, as the most transactions achieved slightly

Table 11. The effect of essential oils treatments on chlorophylls and carotenoids (mg/g f.w.) of gladiolus cut flowers.

Treatments	Cold storage								
	5 days storage			10 days storage			15 days storage		
	Chl.a	Chl.b	Caro.	Chl.a	Chl.b	Caro.	Chl.a	Chl.b	Caro.
Distilled water	0.529	0.156	1.034	0.150	0.062	1.023	0.153	0.064	1.040
HQC at 200 ppm	0.951	0.214	1.489	1.562	0.224	1.372	0.691	0.363	1.070
Clove oil at 1 mg/l	2.181	1.436	1.153	2.104	0.656	1.139	0.787	0.369	2.181
Clove oil at 2 mg/l	0.970	0.214	1.174	0.963	0.663	1.164	0.334	0.297	1.141
Sage oil at 1 mg/l	0.752	0.252	1.442	0.758	0.399	1.401	0.238	0.126	1.488
Sage oil at 2 mg/l	0.965	0.311	2.007	0.773	0.251	1.956	0.615	0.336	1.891

Table 12. The effect of essential oils treatments on total indoles (mg/100 g) and total phenols (%) contents of gladiolus cut flowers.

Treatments	Cold storage					
	5 days storage		10 days storage		15 days storage	
	Total indoles	Total phenols	Total indoles	Total phenols	Total indoles	Total phenols
Distilled water	0.357	3.035	0.350	3.229	0.213	3.479
HQC at 200 ppm	0.488	3.105	0.396	3.114	0.259	2.955
Clove oil at 1 mg/l	0.396	3.312	0.385	3.106	0.228	3.147
Clove oil at 2 mg/l	0.387	2.843	0.379	2.941	0.408	3.453
Sage oil at 1 mg/l	0.506	3.073	0.574	3.286	0.464	3.299
Sage oil at 2 mg/l	0.738	2.979	0.617	3.262	0.685	3.322

Table 13. The effect of essential oils treatments on total indoles (mg/100 g) and total phenols (%) contents of gladiolus cut leaves.

Treatments	Cold storage					
	5 days storage		10 days storage		15 days storage	
	Total indoles	Total phenols	Total indoles	Total phenols	Total indoles	Total phenols
Distilled water	0.345	3.835	0.320	3.829	0.188	3.479
HQC at 200 ppm	0.387	3.105	0.549	3.114	0.379	2.955
Clove oil at 1 mg/l	0.484	3.312	0.488	3.106	0.441	3.147
Clove oil at 2 mg/l	0.332	2.843	0.385	2.941	0.397	2.553
Sage oil at 1 mg/l	0.824	3.073	0.740	3.286	0.704	3.299
Sage oil at 2 mg/l	1.594	2.979	0.557	3.262	0.309	2.322

variable ratios of the amount of total phenols in the leaves and flowering stems in comparison to D.W.

Data in Tables (14 and 15) showed that gladiolus cut spikes when placed in preservative solution containing clove oil had the maximum value of total sugars content compared to control. Increasing amount of total sugars may be attributed to sucrose role in cut flowers. This finding was demonstrated before by Gendy (2000) on gladiolus and Gendy and Mahmoud (2012) who stated that, sucrose treatment increased total sugars percentage in bird of paradise.

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Table 14. The effect of essential oils treatments on total sugars (mg/g d.w.), reducing and non-reducing sugars (mg/g d.w.) of gladiolus cut flowers.

Treatments	Cold storage								
	5 days storage			10 days storage			15 days storage		
	Total sugar	Reducing sugar	Non-reducing sugar	Total sugar	Reducing sugar	Non-reducing sugar	Total sugar	Reducing sugar	Non-reducing sugar
Distilled water	37.44	3.17	34.27	42.28	2.90	38.38	45.74	8.42	37.32
HQC at 200 ppm	52.03	5.33	46.70	50.21	4.72	45.49	55.70	9.76	45.94
Clove oil at 1 mg/l	44.29	4.87	39.42	49.21	4.56	44.65	61.41	15.44	45.97
Clove oil at 2 mg/l	50.85	5.46	45.39	55.97	5.17	50.8	85.03	18.13	66.90
Sage oil at 1 mg/l	37.65	8.63	29.02	64.38	7.06	57.32	86.23	12.48	73.75
Sage oil at 2 mg/l	49.38	9.18	40.20	45.23	5.79	39.44	67.68	13.07	54.61

Table 15. The effect of essential oils treatments on total sugars (mg/g d.w.), reducing and non-reducing sugars (mg/g d.w.) of gladiolus in leaves.

Treatments	Cold storage								
	5 days storage			10 days storage			15 days storage		
	Total sugar	Reducing sugar	Non-reducing sugar	Total sugar	Reducing sugar	Non-reducing sugar	Total sugar	Reducing sugar	Non-reducing sugar
Distilled water	23.82	3.16	20.66	20.11	3.68	16.43	21.54	6.07	15.47
HQC at 200 ppm	25.20	8.62	16.58	25.88	4.10	21.78	40.91	7.45	35.46
Clove oil at 1 mg/l	29.36	4.48	24.88	26.17	3.59	22.58	28.36	11.74	16.62
Clove oil at 2 mg/l	40.09	2.02	38.07	26.09	4.26	21.83	35.29	8.00	27.29
Sage oil at 1 mg/l	46.77	4.68	42.09	17.86	4.85	13.01	30.78	7.11	23.67
Sage oil at 2 mg/l	52.30	3.97	48.33	16.81	5.53	11.28	34.00	8.35	25.65

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تأثير إستخدام الزيوت العطرية على تخزين وحفظ جودة أزهار الجلاديولس المقطوفة

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أجريت التجارب في معمل معاملات ما بعد الحصاد، بقسم بحوث الزينة وتنسيق الحدائق، معهد بحوث البساتين بالجيزة، مصر خلال موسمي ٢٠١٩ و٢٠٢٠ وذلك لدراسة تأثير الزيوت العطرية بتجربتين وهي استخدام محاليل حفظ الأزهار المقطوفة كمحلول حفظ أو رش ثم تخزين الأزهار المقطوفة تحت تأثير درجات حرارة منخفضة على ثلاث فترات وتأثيرها على فترة بقاء وجودة أزهار الجلاديولس المقطوفة. التجربة الأولى تشمل خمس محاليل حفظ وهي زيت القرنفل بتركيز ١ و٢ ملجم/لتر + ٢٠ جم/لتر سكروز وزيت مريمية بتركيز ١ و٢ ملجم/لتر + ٢٠ جم/لتر سكروز وهيدروكسى كينولين سترات بتركيز ٢٠٠ملجم/لتر + ٢٠ جم/سكروز وكانت معاملة الكنترول بماء مقطر، وفى التجربة الثانية كان استخدام الزيوت العطرية رشاً على الأزهار المقطوفة. وأكدت النتائج المتحصل عليها من التجارب أن الأزهار المقطوفة التي وُضعت في محلول حفظ مكون من زيت القرنفل ١ ملجم/لتر +٢٠ جم/لتر سكروز سجلت زياده معنوية في إطالة فترة بقاء الأزهار المقطوفة و زيادة النسبة المئوية للوزن الطازج للأزهار وكمية الماء الممتص في الأزهار وكذلك الوزن الجاف و زيادة في النسبة المئوية لتفتح الازهار وتقليل كمية الماء المفقود من الأزهار مع نقص العدد البكتيري في محلول الفازة. وكان للزيوت العطرية تأثير إيجابي على تركيز السكريات الكلية في الأزهار ومقدار الإندولات الكلية والنسبة المئوية للفينولات وكمية الكلورفيل الكلية في الأزهار المقطوفة. استخدام الزيوت العطرية كبديل للمركبات الكيميائية لها تأثير ممتاز على أزهار القطف أيضاً بسبب أنشطتها المضادة للميكروبات وطبيعتها الصديقة للبيئة.