Vase Life of Cut Tuberose (*Polianthes tuberosa L.*) as Affected by Some Postharvest Treatments

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ABSTRACT: Keeping quality and length of vase life are important factors for evaluating of cut flowers quality, for both domestic and export markets. These investigations proposed to determine the effectiveness of peppermint oil at (50, 100, 150, and 200) mg/l in 1 Liter distilled water + 4% sucrose, thyme oil at (25, 50, 75, and 100) mg/l in 1 Liter distilled water + 2% sucrose, black cumin oil at (25, 50, 75, and 100) mg/l in 1 Liter distilled water + 2% sucrose, rosemary oil at (50, 100, 150, and 200) mg/l in 1 Liter distilled water + 4% sucrose, ethanol at (5, 10, 15, and 20) mg/l in 1 Liter distilled water + 2% sucrose, salicylic acid at (25, 50, 100, and 150 mg/l in 1 Liter distilled water + 2% sucrose and cut flowers were pulsed in 1Liter tap water at the same time of control on quality parameters of tuberose (*Polianthes tuberosa L.*) cut flowers. Results showed that all treatments significantly increased the vase life, fresh weight, water uptake, protein accumulation and total soluble solids with decreasing number of bacteria compared to control in both experiments. In addition, peppermint oil at (150 and 200) mg/l, thyme oil at (75 and 100) mg/l, black cumin oil at 100 mg/l, rosemary oil at 200 mg/l and salicylic acid at (50, 100 and 150) mg/l were more effective on improving the quality parameters than other treatments.

Key words: Tuberose, Vase Life, Essential Oils, Ethanol, Salicylic Acid, Cut Flowers

INTRODUCTION

Short postharvest vase- life of cut flowers is one of the most important problems of cut flowers. Senescence of cut flowers is induced by several factors e.g. water stress, carbohydrate depletion, microorganisms and ethylene effects (Zamani *et al*., 2011). Tuberose (*Polianthes tuberosa L.*) is a perennial bulbous plant of Asparagaceae. Tuberose is a popular and commercially valuable cut flower produced worldwide (Bahadoran *et al*., 2012). The florets have a very sweet fragrance and are widely cultivated in India and France as a source of essential oils for the perfume industry. *Polianthes* is also a common garden plant in the spring and it flowers during the summer and early autumn (De Hertogh and Le Nard, 1993). Two major cultivars, white-colored 'Single' and 'Double', are used for commercial production (Shen *et al*., 2003). In tuberose, fewer than 50% of the buds normally open after harvest and florets and buds usually drop off after a few days in vase. Postharvest performance is worse in tuberose which has been shipped to distant markets (Waithaka *et al.,* 2001). Keeping quality of spikes is only three days for florets and vase life of flowers is only a few days. Since it has delicate flowers and sellers and customers are keen to extend its vase life, it is necessary to improve its postharvest life (Anjum *et al*., 2001).

In the cut flowers of tuberose, wilting and burning of florets and bending of the tips of flower spikes are the major problems that reduce the vase life of cut flowers (Jowkar and Salehi, 2005). Various factors such as ethylene sensitivity, bacterial contamination, vascular blockage, and oxidative stress cause petal burning or browning, and floret wilting or abscission in cut flowers (Shahri and Tahir, 2011). Moreover, various agents such as microbial activities, air obstruction and physiological response to cutting wound, gum aggregation in xylem, latex leakage, and other processes in the wound lead to vascular blockage and prevent water uptake, which reduces the freshness of cut flowers (Imsabai *et al*., 2013). Additionally, recent studies on some cut flowers demonstrated that, with decrease in the freshness of cuts, some bacteria aggregate in the vase solution and lead to senescence of cut flowers (Macnish *et al*., 2008). By using some acids as antibacterial compounds, the frequency of bacteria in the vase solution can be decreased and the vase life of various cut flowers significantly increased, which is supposedly due to the reduction in vascular blockage (Mansouri, 2012).

Several solutions were used as pulsing or preservative solutions for increasing the longevity of cut flowers. Those chemicals are very expensive and most harmful preservative for human causing irritating to skin, eyes and respiratory tract as well as using natural products did not have large attentions as safe materials in vase solutions **(**Mohamed, 2015). A suitable method for vase life extension, which easy to use, natural, safe and inexpensive compounds is always crucial in this respect for large-scale applications (Soleimany-Fard *et al*., 2013). Essential oils (EOs), natural products taken from plant materials that, due to their antibacterial, antifungal, antioxidant and anticarcinogenic properties can be used as natural additives in many crops (Teissedre and Water-house, 2000). Thyme (*Thymus vulgaris*) essential phenolic oil has been counted to have antibacterial, antimycotic and antioxidative properties (Deans *et al*., 1993). Its majority components were thymol, carvacrol also borneol (Jakiemiu *et al*., 2010). Essential oils of black cumin (*Bunium persicum*) also have strong anti-bacterial effects. This feature could be resulted from the relatively high amount of terpenes and cumin aldehyde in the essential oil (Moghtader *et al*., 2009). Moreover, menthol is the main component of peppermint (*Mentha piperita*). The essential oils of it show strong antibacterial activity (Işcan *et al*., 2002).

Rosemary is one of the most effective spices widely used in food processing, is well cultivated in Egypt, and is the only spice commercially available for use as an antioxidant in Europe and the United States (Yanishlieva *et al*., 2006). The antioxidant properties of rosemary are well documented (Kadri *et al*., 2011). Moreover, Salicylic acid is considered to be a potent plant hormone because of its diverse regulatory roles in plant metabolism. It was first extracted from willow trees, and named after the Latin word “Salix”. Salicylic acid has been found to play a key role in the regulation of plant growth, development and in responses to environmental stresses. Further, its role is evident in ion uptake and transport, photosynthetic rate, stomata conductance and transpiration. Tehranifar *et al*. (2013). In addition, low concentration of

ethanol decreased the formation of ethylene, because it inhibited the action of ACC synthase thereby affecting flower wilting, abscission, scar and color change (Hossain *et al*., 2007). This work has been done to examine the effect of some materials as preservative solutions that can be effective and safe for human and environment (peppermint oil, thyme oil, black cumin oil, rosemary oil, ethanol and salicylic acid). The aim of this study was to extend vase life of cut tuberose flowers through using essential oils and some solutions. Moreover to find out most effective concentration among the materials used to produce the best quality of cut flowers with longer vase life.

MATERIALS AND METHODS

Two separate experiments were conducted in the Plant Production Department, Faculty of Agriculture, Saba Basha, Alexandria University in September and October, 2016 on tuberose cut flowers.

Materials and preparation of cut flowers

The cut flowers used for this investigation; Tuberose**,** (*Polianthes tuberosa L.*) ‘‘Pearl’’ were obtained from a well-known commercial nursery in Cairo. Cut spikes were cut from the field in early morning, harvested with two or three open florets, wrapped with polyethylene sheet, and then quickly moved to the experiment room, of an average temperature of (28°±1 ℃) for first experiment, while for the second (22°±1 ℃), and (65-75%) relative humidity and light from a white fluorescent lamp. Stems were cut at (70-75 cm) and trimmed to (60 cm) before postharvest treatments. Leaves of the lower third part of the stem were removed to avoid contamination in the vase solution as recommended by Khimani *et al*. (2005).

Essential oils used in the experiments

- Peppermint oil: peppermint oil was used with concentrations of 50, 100, 150, and 200 mg/l of distilled water + 4% sucrose.
- Thyme oil: thyme oil was used with concentrations of 25, 50, 75, and 100 mg/l of distilled water + 2% sucrose.
- Black cumin oil: black cumin oil was used with concentrations of 25, 50, 75, and 100 mg/l of distilled water + 2% sucrose.
- Rosemary oil: rosemary oil was used with concentrations of 50, 100, 150, and 200 mg/l of distilled water + 4% sucrose.
- Ethanol: ethanol was used with concentrations of 5, 10, 15, and 20 mg/l of distilled water + 2% sucrose.
- Salicylic acid: salicylic acid was used with concentrations of 25, 50, 100, and 150 mg/l of distilled water + 2% sucrose.
- Control flowers: control cut flowers were pulsed in 1Liter tap water at the same time of the other treatments.

Pulsing solutions

The flowers were given pre-treatments of pulsing solutions which were freshly prepared at the start of experiments from (different concentrations of

peppermint oil, thyme oil, black cumin, rosemary oil, ethanol, salicylic acid of distilled water contained 2 or 4% sucrose) in plastic container for 24 hours.

Holding solutions

The flowers were moved to glass containers (Vases) which contained 300 ml of distilled water to calculate the vase life and the tested parameters. The water in the vases replacement and also about 1 cm of the stems was cut every 3 days. Vases were exposed every day at night to light from a white fluorescent lamp for 12 hours and during the day were exposed to daylight. The room temperature was (28°±1 ℃) for first experiment, while for the second (22°±1 ℃), relative humidity (R.H.) was about (65- 75%).

Experimental layout and statistical analysis

The treatments were arranged in a Randomized Complete Block Design (RCBD), in two factors (solutions and time) with three replications for each treatment. Each replicate consisted of one glass bottle (vase) in which (5 cut flowers of tuberose) was placed. Then each treatment was represented by 15 cut flowers/treatment. All data obtained throughout the course of this study were statistically analysed by the analysis of variance as described by (Steel and Torrie, 1980), all analysis were done by means of (SAS, 2002) statistical software.

Treatments

Tuberose cut flower experiments:

The first experiment started in 4th of September 2016, while the second experiment started in 23rd of October 2016. The first experiment ended in 15th of September 2016, while the second experiment ended in 7th of November 2016.

The collected data:

Tuberose vase life (days):

The vase life of cut inflorescences was considered when the number of senesced florets exceeded the number of open ones. On the other hand, loss or wilting of 50% of florets mark the end of vase life (Dole *et al*.,1999).

Total fresh weight (g):

The average fresh weight of fresh stems carrying leaves and the flowers were calculated (Barakat, 2013).

Water uptake (g):

The volume of water uptake was calculated by subtracting the volume of water evaporated from a control bottle without cut flowers and the amount of water decreased in bottles containing flowers (Zamani *et al*., 2011).

Number of bacteria (CFU/ml):

Bacterial contamination was determined in the keeping solution at the end of experiment. 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 days at 28℃ and the colonies appearing on the plates were counted. This experiment was repeated two times with 3 replicates in each treatment at the laboratory of Microbiology Department, Faculty of Agriculture, Saba Basha, Alexandria University (Gendy and Mahmoud, 2012).

Determination of protein content in leaves (%):

The protein content has been determined on the basis of total nitrogen content, while the Kjeldahl (or similar) method has been almost universally applied to determine nitrogen content (A.O.A.C. 2000). Nitrogen content is then multiplied by a factor to give protein content. On the basis of early determinations, the average nitrogen (N) content of proteins was found to be about 16 percent, which led to use of the calculation N x 6.25 (1/0.16 = 6.25) to convert nitrogen content into protein content (Agriculture and Consumer Protection, 2003).

Total soluble solids (T.S.S %):

Total soluble solids in the extracted juice of tuberose petals were measured by a hand refractometer (Brix % 20° C) as reported by **Lacey** ***et al*****. (2001)**.

RESULTS AND DISSCUSSION

Vase Life

The effect of some essential oils, ethanol and salicylic acid on vase life of tuberose cut flowers in the first and second experiments (September and October, 2016), are presented in Table (1). It has been found that all studied materials had remarkable significant effect on increasing vase life compared to control in both experiments. In addition, peppermint oil at 150 and 200 mg/l, thyme oil at 75 and 100 mg/l, black cumin oil at 100 mg/l, ethanol at 15 and 20 mg/l and salicylic acid at (50, 100 and 150) mg/l in two experiments were more effective on increasing vase life than other treatments. These significant increases in vase life may be because of salicylic acid (SA), a natural phenolic secondary metabolite, play role in various aspects of vital processes like ethylene biosynthesis, stomatal conductance, respiration, senescence and the activation of defense systems against different pathogens as recorded by (An and Mou 2011). SA treatments were effective in postharvest life of cut flowers probably via the declined bacterial growth, reduced vascular blockage, reduced transpiration, prevented ethylene formation and induced antioxidant system in treated cut flowers thereby delaying the senescence process as confirmed by Danaee *et al*. (2013). These results are in accordance with those of Roodbaraky *et al*. (2012), Kazemi *et al*. (2012a) on carnation and Soleimany-Fard *et al*. (2013) on alstroemeria flowers. They indicated that salicylic acid increased the vase life of cut flowers compared to control. Also, Heins and

Blakely (1980) reported that ethanol has been examined successfully in prolonging the vase life of cut carnations and chrysanthemum flowers by inhibiting ethylene biosynthesis and their antimicrobial effects.

During senescence, marked changes occur in the biochemical and biophysical properties of the cell membranes. Ethylene plays a central role in the senescence of many cut flowers as proved by Reid (1989). Flower vase life is affected by respiration, carbohydrates deterioration, disease inoculation, water uptake etc. During vase life of cut flowers, ethylene synthesis plays a major role in senescence. Similarly carbohydrates and soluble sugars in the petals also help in quality retention of cut flowers for longer period as found by Hussen and Yassin (2013). There was a direct relationship between vase life and, increasing of relative fresh weight and water uptake. Obstruction of the xylems by bacteria, therefore, inability of water absorption by flower stems is one of the current problems that lead to decrease in flowers postharvest longevity and also early wilting as observed by Sardoei *et al*. (2014).

Table (1). Effect of some essential oils, ethanol and salicylic acid on the vase life (days) of tuberose cut flowers in the first and second experiments (September and October, 2016)

Treatments	Vase life (days)	
	September, 2016	**October, 2016**
Control	6.43	7.08
Peppermint oil 50 mg/l + 4% sucrose	7.85	8.63
Peppermint oil 100 mg/l + 4% sucrose	8.72	9.59
Peppermint oil 150 mg/l + 4% sucrose	9.72	10.66
Peppermint oil 200 mg/l + 4% sucrose	10.77	14.51
Thyme oil 25 mg/l + 2% sucrose	7.36	8.15
Thyme oil 50 mg/l + 2% sucrose	8.17	9.05
Thyme oil 75 mg/l + 2% sucrose	9.08	10.06
Thyme oil 100 mg/l + 2% sucrose	10.09	11.18
Black cumin oil 25 mg/l + 2% sucrose	7.47	8.21
Black cumin oil 50 mg/l + 2% sucrose	8.29	9.13
Black cumin oil 75 mg/l + 2% sucrose	9.22	10.14
Black cumin oil 100 mg/l + 2% sucrose	10.24	11.27
Rosemary oil 50 mg/l + 4% sucrose	7.15	7.86
Rosemary oil 100 mg/l + 4% sucrose	7.94	8.74
Rosemary oil 150 mg/l + 4% sucrose	8.83	9.71
Rosemary oil 200 mg/l + 4% sucrose	9.81	10.79
Ethanol 5 mg/l + 2% sucrose	7.61	11.37
Ethanol 10 mg/l + 2% sucrose	8.46	11.63
Ethanol 15 mg/l + 2% sucrose	9.40	12.67
Ethanol 20 mg/l + 2% sucrose	10.44	13.49
Salicylic acid 25 mg/l + 2% sucrose	8.23	12.72
Salicylic acid 50 mg/l + 2% sucrose	9.14	13.73
Salicylic acid 100 mg/l + 2% sucrose	10.16	13.18
Salicylic acid 150 mg/l + 2% sucrose	11.29	14.09
Average	**8.87**	**10.71**
LSD (0.05)	**0.10**	**0.75**

Various studies indicated that bacterial contamination was one of the most important factors in reducing postharvest life of cut flowers with the negative impact on respiration, photosynthesis and water uptake, also increasing the evaporation, caused water imbalance and indirectly stimulated ethylene production and shortened postharvest life of cut flowers as found by Mohammadi *et al.* (2012). According to the scientific findings, the postharvest life of different ornamental cut flowers could be affected by the application of various chemicals as preservatives by Danaee *et al.* (2013). Anti- ethylene and antimicrobial compounds can control ethylene production and extending vase life of cut flowers as confirmed by Hashemabadi *et al.* (2015). In general, the greatest longevity associated with higher values in the water variables related to water consumption, transpiration and water flow. Longevity also associated with the lower values in vascular blockage as reported by Cortes *et al.* (2011).

Heins and Blakely (1980), Wu *et al.* (1992) and Petridou *et al.* (1999) reported that using 8% and 10% ethanol extended vase life of carnation by causing delay senescence. Ethanol and methanol have also been tested successfully in prolonging the vase life of cut carnations and the concentration that was effective in increasing vase life of carnation flowers ranged from 2% to 8%. Solgi *et al.* (2009) reported that Iranian thyme and thyme EOs are used in preserving solution for extending the vase life of gerbera cut flower. Bahrami *et al.* (2013) evaluated the effect of different concentrations of salicylic acid on vase life of cut lisianthus (*Eustoma grandiflora*) and reported that 100 mg/L of salicylic acid enhanced solution uptake and vase life compared control. Basiri *et al.* (2011) showed that the use of treatment, 25% rosemary extract with 6% sucrose in the preservative solution of Dianthus, increased the vase life of flowers to 24 days.

Total fresh weight

Data concerning the effect of some essential oils, ethanol and salicylic acid on total fresh weight of petals of tuberose cut flowers in the first and second experiments (September and October, 2016), are listed in Tables (2 and 3). Results, generally, showed that all used treatments significantly increased the total fresh weight compared to control. In addition, peppermint oil at (150 and 200) mg/l, thyme oil at (75 and 100) mg/l, black cumin oil at 100 mg/l**,** rosemary oil at 200 mg/l and salicylic acid at (50, 100 and 150) mg/l were more effective on increasing total fresh weight than other treatments. With regard to salicylic acid treatments the findings proved to be in accordance to those of Mashhadian *et al.* (2012) on chrysanthemum and Marandi *et al.* (2011) on gladiolus, they reported that salicylic acid enhanced the fresh weight. In addition, Sabzi *et al.* (2012) and Ashtari *et al.* (2013), showed that salicylic acid was the most effective on preventing rose cut flowers from reduction of wet weight. This increase of fresh weight by treatments of salicylic acid may be due to its antimicrobial activity (inhibiting vascular blockage), which increases the water uptake and decreases the transpiration rate, thereby enhancing water balance of cut flowers which might be due to the possibility of salicylic acid to decrease the pH of vase solution and consequently, reduced the growth and proliferation of bacteria, which led to increasing water uptake as proved by

Soleimany-Fard *et al.* (2013), Danaee *et al.* (2013) reported that the treatment of SA led to the induced activities of the mentioned enzymes in comparison to the control. The production of reactive oxygen species suggested as a main signal for alerting and modifying metabolism and gene expression.

Table (2). Effect of some essential oils, ethanol and salicylic acid on the total fresh weight (g) of tuberose cut flowers in the first experiments (September, 2016)

Treatments	Total fresh weight (g)				
	Vase life (days)				Average
	Initial Time	4	8	12	
Control	48.36	40.27	32.21	25.77	36.65
Peppermint oil 50 mg/l + 4% sucrose	64.48	51.58	41.26	33.01	47.58
Peppermint oil 100 mg/l + 4% sucrose	71.64	57.31	45.85	36.68	52.87
Peppermint oil 150 mg/l + 4% sucrose	79.61	63.68	50.94	40.75	58.75
Peppermint oil 200 mg/l + 4% sucrose	88.45	70.76	57.27	45.28	65.44
Thyme oil 25 mg/l + 2% sucrose	56.78	45.58	36.47	29.17	42.00
Thyme oil 50 mg/l + 2% sucrose	63.09	50.47	40.37	32.30	46.56
Thyme oil 75 mg/l + 2% sucrose	70.11	56.08	44.86	35.89	51.74
Thyme oil 100 mg/l + 2% sucrose	77.90	62.32	49.85	39.03	57.27
Black cumin oil 25 mg/l + 2% sucrose	59.03	47.23	37.78	30.22	43.57
Black cumin oil 50 mg/l + 2% sucrose	65.59	52.47	41.98	33.58	48.41
Black cumin oil 75 mg/l + 2% sucrose	72.88	58.30	46.64	37.31	53.78
Black cumin oil 100 mg/l + 2% sucrose	80.98	64.78	51.82	41.46	59.76
Rosemary oil 50 mg/l + 4% sucrose	53.74	42.99	34.39	27.51	39.66
Rosemary oil 100 mg/l + 4% sucrose	59.71	47.76	38.21	30.56	44.06
Rosemary oil 150 mg/l + 4% sucrose	66.34	53.07	42.45	33.96	48.95
Rosemary oil 200 mg/l + 4% sucrose	73.71	58.97	47.18	37.74	54.40
Ethanol 5 mg/l + 2% sucrose	61.66	49.32	39.46	31.55	45.50
Ethanol 10 mg/l + 2% sucrose	68.51	54.80	43.84	35.07	50.56
Ethanol 15 mg/l + 2% sucrose	76.19	60.95	47.15	37.72	55.50
Ethanol 20 mg/l + 2% sucrose	84.58	67.66	54.13	43.30	62.42
Salicylic acid 25 mg/l + 2% sucrose	70.00	56.00	44.80	35.84	51.66
Salicylic acid 50 mg/l + 2% sucrose	77.78	62.22	49.77	39.82	57.40
Salicylic acid 100 mg/l + 2% sucrose	86.42	69.14	55.31	44.24	63.78
Salicylic acid 150 mg/l + 2% sucrose	96.03	76.82	61.65	49.32	70.96
Average	**70.94**	**56.82**	**45.42**	**36.30**	
LSD (0.05)	**D: 0.36**		**T: 0.91**	**D×T: 1.83**	
D: Vase Life	**T: Treatments**		**D×T: Interaction**		

Table (3). Effect of some essential oils, ethanol and salicylic acid on the total fresh weight (g) of tuberose cut flowers in the second experiments (October, 2016)

Treatments	Total fresh weight (g)				
	Vase life (days)				Average
	Initial Time	4	8	12	
Control	53.19	44.30	35.44	28.12	40.26
Peppermint oil 50 mg/l + 4% sucrose	70.92	56.74	45.54	36.67	52.47
Peppermint oil 100 mg/l + 4% sucrose	78.81	63.04	50.27	40.34	58.12
Peppermint oil 150 mg/l + 4% sucrose	87.57	70.05	56.04	44.83	64.62
Peppermint oil 200 mg/l + 4% sucrose	97.29	77.83	62.26	49.81	71.80
Thyme oil 25 mg/l + 2% sucrose	62.46	50.14	40.11	32.08	46.20
Thyme oil 50 mg/l + 2% sucrose	69.38	55.68	44.41	35.53	51.25
Thyme oil 75 mg/l + 2% sucrose	77.11	61.69	49.35	39.48	56.91
Thyme oil 100 mg/l + 2% sucrose	85.69	68.55	54.84	42.95	63.01
Black cumin oil 25 mg/l + 2% sucrose	64.93	51.95	41.56	33.25	47.92
Black cumin oil 50 mg/l + 2% sucrose	72.15	57.72	46.17	36.94	53.24
Black cumin oil 75 mg/l + 2% sucrose	80.17	64.13	51.30	41.04	59.16
Black cumin oil 100 mg/l + 2% sucrose	89.08	71.25	57.00	45.60	65.73
Rosemary oil 50 mg/l + 4% sucrose	59.11	47.28	37.83	30.26	43.62
Rosemary oil 100 mg/l + 4% sucrose	59.62	52.54	42.02	33.62	46.95
Rosemary oil 150 mg/l + 4% sucrose	72.97	58.37	46.69	37.25	53.82
Rosemary oil 200 mg/l + 4% sucrose	81.08	64.86	51.89	41.52	59.84
Ethanol 5 mg/l + 2% sucrose	67.83	54.25	43.41	34.70	50.05
Ethanol 10 mg/l + 2% sucrose	75.25	60.28	48.22	38.59	55.59
Ethanol 15 mg/l + 2% sucrose	83.81	67.04	51.86	41.48	61.05
Ethanol 20 mg/l + 2% sucrose	93.04	74.43	59.54	47.63	68.66
Salicylic acid 25 mg/l + 2% sucrose	77.00	61.60	49.28	39.42	56.83
Salicylic acid 50 mg/l + 2% sucrose	85.56	68.44	54.75	43.80	63.14
Salicylic acid 100 mg/l + 2% sucrose	95.06	76.05	60.84	48.67	70.15
Salicylic acid 150 mg/l + 2% sucrose	105.63	84.72	67.82	54.25	78.10
Average	**77.79**	**62.52**	**49.94**	**39.91**	
LSD (0.05)	**D: 0.21**		**T: 1.33**		**D×T: 2.66**
D: Vase Life	**T: Treatments**		**D×T: Interaction**		

In agreement with these results are those obtained by Hatamzadeh *et al.* (2011) who demonstrated that the salicylic acid at 150 mg/L delayed flower senescence and decreased fresh weight loss. Marandi *et al.* (2011) found that salicylic acid 1.5 mM treatment showed the best effect on fresh weight percent. Also, Kazemi *et al.* (2012a) showed that acetylsalicylic acid treatments increased fresh weight.

As for the effect of vase life period's data indicated that total fresh weight decreased in both experiments, with increasing the vase life periods and the differences among all tested vase life periods were statistically significant compared with the initial time. The increment in relative fresh weight at initial vase life days could be due to the higher solution uptake during the early storage time as supported by Seyf *et al.* (2012). Furthermore, Alaey *et al.*

(2011) reported that the highest relative fresh weight of cut rose flowers was observed in vase solutions which showed the greatest water uptake. The decrease in relative fresh weight of cut flowers during the days of after harvest could be due to the decrease in water uptake (Soleimany-Fard *et al.* 2013).

Water uptake

Data concerning the effect of some essential oils, ethanol and salicylic acid on water uptake of tuberose cut flowers in the first and second experiment (September and October, 2016), are listed in Tables (4 and 5). Data in general showed that, all treatments increased water uptake compared with control. In addition, the statical analysis showed that peppermint oil at (100, 150 and 200) mg/l, black cumin oil at 100 mg/l ethanol at (15 and 20) mg/l and salicylic acid at (50, 100 and 150) mg/l were more effective on increasing water uptake than other treatments. The enhancing effect of salicylic acid on water uptake may be related to the role of salicylic acid in reducing microbial population in vase solution of cut flowers and/or positive regulatory role of SA on stomata closure which regulates the rates of transpiration and increases the water-retaining capacity of leaves and petals as demonstrated by Kazemi *et al.* (2011a, b, and c) and Khenizy *et al.* (2013). In addition, the role of salicylic acid is evident in ion uptake and transport and also photosynthetic rate, stomata conductance and transpiration as reported by Khan *et al.* (2003). Similar results obtained by Kazemi *et al.* (2011c) on gerbera, Zadeh and Mirzakhani (2012) on carnation and Soleimany-Fard *et al.* (2013) on alstroemeria cut flower revealed that salicylic acid increased water absorption compared to control.

As the effect of vase life periods on the changes of water uptake, it was significantly increased with increasing vase life period, and the differences among all tested vase life period were statistically significant compared with initial date in the two experiments. The increase in water uptake of cut flowers during vase period was probably due to growth of microbes and vascular blockage suggesting that adding a suitable germicide in vase solution can prevent the growth of microbes and increase water uptake as confirmed by Anjum *et al.* (2001). Hashemabadi *et al.* (2015) demonstrated that enhancement of vase life can be described with antimicrobial properties of the above mentioned compounds, so that water absorption improved with prevention of vascular blockage and it delays water deficiency related wilting and reported that anti-ethylene compounds and also antibiotics increase water absorption, significantly.

Number of bacteria (CFU /ml)

The effects of some essential oils, ethanol and salicylic acid on the number of tuberose cut flowers in the first and second experiments (September and October, 2016), are shown in Table (6). Data proved that the number of bacteria in vase solution was decreased significantly by using all studied materials compared to control. Moreover, the best effect on decreasing the number of bacteria was obtained by peppermint oil at (150 and 200) mg/l, ethanol at 20 mg/l and salicylic acid at (50, 100 and 150) mg/l in both experiments. These results are in agreement with those obtained by Kazemi and Ameri (2012) and Kazemi *et al.* (2012b) on carnation. They observed a

significant effect of salicylic acid on bacterial population. Effectiveness of salicylic acid might be referred to its ability to decrease pH of vase solution which reduce the growth and proliferation of bacteria as confirmed by Soleimany-Fard *et al.* (2013). Kazemi and Shokri (2011), who demonstrated that, 3 percent sucrose+1.5 mM salicylic acid significantly decreased bacteria populations.

Table (4). Effect of some essential oils, ethanol and salicylic acid on the water uptake (g) of tuberose cut flowers in the first experiment (September, 2016)

Treatments	Water uptake (g)				
	Vase life (days)				Average
	2	4	8	12	
Control	162.05	117.41	140.16	75.12	123.69
Peppermint oil 50 mg/l + 4% sucrose	200.72	160.57	139.07	111.26	152.90
Peppermint oil 100 mg/l + 4% sucrose	223.02	178.41	171.39	123.62	174.11
Peppermint oil 150 mg/l + 4% sucrose	247.80	198.24	171.70	137.36	188.77
Peppermint oil 200 mg/l + 4% sucrose	275.33	220.27	190.77	152.62	209.75
Thyme oil 25 mg/l + 2% sucrose	178.61	135.69	102.72	82.16	124.79
Thyme oil 50 mg/l + 2% sucrose	188.46	150.77	114.13	91.31	136.17
Thyme oil 75 mg/l + 2% sucrose	209.40	167.52	126.81	101.45	151.30
Thyme oil 100 mg/l + 2% sucrose	232.67	186.13	140.91	112.72	168.11
Black cumin oil 25 mg/l + 2% sucrose	177.39	141.91	113.53	90.81	130.91
Black cumin oil 50 mg/l + 2% sucrose	197.10	157.68	126.14	100.91	145.46
Black cumin oil 75 mg/l + 2% sucrose	219.00	175.20	156.83	112.12	165.79
Black cumin oil 100 mg/l + 2% sucrose	243.33	194.67	155.73	124.58	179.58
Rosemary oil 50 mg/l + 4% sucrose	180.06	130.44	104.35	83.47	124.58
Rosemary oil 100 mg/l + 4% sucrose	200.07	144.94	115.96	92.74	138.43
Rosemary oil 150 mg/l + 4% sucrose	222.30	161.04	128.83	103.05	153.80
Rosemary oil 200 mg/l + 4% sucrose	223.67	178.93	143.15	114.52	165.07
Ethanol 5 mg/l + 2% sucrose	190.27	152.21	121.77	97.42	140.42
Ethanol 10 mg/l + 2% sucrose	211.41	169.29	135.30	108.24	156.06
Ethanol 15 mg/l + 2% sucrose	234.90	187.92	150.33	120.27	173.36
Ethanol 20 mg/l + 2% sucrose	261.00	208.80	167.04	133.63	192.62
Salicylic acid 25 mg/l + 2% sucrose	208.74	162.88	133.59	110.88	154.02
Salicylic acid 50 mg/l + 2% sucrose	231.93	180.79	148.63	118.73	170.02
Salicylic acid 100 mg/l + 2% sucrose	257.70	200.88	164.92	131.92	188.86
Salicylic acid 150 mg/l + 2% sucrose	286.33	229.07	183.25	146.60	211.31
Average	**218.53**	**171.67**	**141.88**	**111.10**	
LSD (0.05)	**D: 9.38**		**T: 7.26**		**D×T: 14.51**
D: Vase Life	**T: Treatments**		**D×T: Interaction**		

Table (5). Effect of some essential oils, ethanol and salicylic acid on the water uptake (g) of tuberose cut flowers in the second experiment (October, 2016)

Treatments	Water uptake (g)				
	Vase life (days)				Average
	2	4	8	12	
Control	159.76	127.81	102.24	81.79	117.90
Peppermint oil 50 mg/l + 4% sucrose	220.79	176.63	141.29	113.04	162.94
Peppermint oil 100 mg/l + 4% sucrose	245.32	196.26	157.01	125.60	181.05
Peppermint oil 150 mg/l + 4% sucrose	272.58	218.06	174.27	139.58	201.12
Peppermint oil 200 mg/l + 4% sucrose	302.87	242.29	193.83	155.07	223.52
Thyme oil 25 mg/l + 2% sucrose	186.57	149.26	119.55	95.52	137.73
Thyme oil 50 mg/l + 2% sucrose	207.30	165.84	132.83	106.13	153.03
Thyme oil 75 mg/l + 2% sucrose	230.34	184.27	147.60	117.93	170.03
Thyme oil 100 mg/l + 2% sucrose	255.93	171.41	163.80	131.03	180.54
Black cumin oil 25 mg/l + 2% sucrose	195.13	152.60	122.08	95.60	141.35
Black cumin oil 50 mg/l + 2% sucrose	211.95	169.56	135.55	106.22	155.82
Black cumin oil 75 mg/l + 2% sucrose	235.50	188.40	150.72	118.02	173.16
Black cumin oil 100 mg/l + 2% sucrose	267.67	209.33	167.47	131.14	193.90
Rosemary oil 50 mg/l + 4% sucrose	179.36	143.48	110.49	91.83	131.29
Rosemary oil 100 mg/l + 4% sucrose	199.30	157.76	122.77	102.03	145.47
Rosemary oil 150 mg/l + 4% sucrose	221.43	176.98	136.41	113.36	162.04
Rosemary oil 200 mg/l + 4% sucrose	246.03	196.83	157.46	125.96	181.57
Ethanol 5 mg/l + 2% sucrose	209.17	167.43	128.93	111.17	154.18
Ethanol 10 mg/l + 2% sucrose	232.41	186.04	152.25	123.52	173.56
Ethanol 15 mg/l + 2% sucrose	258.24	206.71	165.36	137.25	191.89
Ethanol 20 mg/l + 2% sucrose	287.10	229.68	183.74	132.66	208.29
Salicylic acid 25 mg/l + 2% sucrose	229.61	165.72	159.39	127.53	170.56
Salicylic acid 50 mg/l + 2% sucrose	255.12	190.02	177.10	141.69	190.98
Salicylic acid 100 mg/l + 2% sucrose	283.47	218.49	196.78	157.44	214.05
Salicylic acid 150 mg/l + 2% sucrose	314.97	218.62	218.65	174.92	231.79
Average	**236.32**	**184.38**	**152.70**	**122.24**	
LSD (0.05)	**D: 8.66**		**T: 9.73**		**D×T: 19.46**
D: Vase Life	**T: Treatments**		**D×T: Interaction**		

Essential oils are very effective antimicrobial agents, which inhibited the microbial growth and prevented bacterial plugging of water conducting tissues so they should increase vase life of cut flowers. Awang (1998) indicated that menthol is the main component of peppermint and the essential oils of it expressed strong antibacterial activity. Also Moghtader *et al.* (2009) reported that essential oils of Black cumin have strong antibacterial effects. This feature could be resulted from the relatively high amount of terpenes and cumin aldehyde in the essential oil.

Essential oils of Black cumin also have strong anti-bacterial effects. This feature could be resulted from the relatively high amount of terpenes and cumin aldehyde in the essential oil (Moghtader *et al*., 2009). Menthol is the main

component of peppermint, The essential oils of it show strong antibacterial activity (Awang, 1998; Ernestt and Pittler, 2001).

Table (6). Effect of some essential oils, ethanol and salicylic acid on the number of bacteria (CFU, Colony Forming Unit / ml) of tuberose cut flowers in the first and second experiments (September and October, 2016)

Treatments	Number of bacteria (CFU/ ml)	
	September, 2016	October, 2016
Control	146	116
Peppermint oil 50 mg/l + 4% sucrose	112	88
Peppermint oil 100 mg/l + 4% sucrose	101	81
Peppermint oil 150 mg/l + 4% sucrose	92	74
Peppermint oil 200 mg/l + 4% sucrose	84	67
Thyme oil 25 mg/l + 2% sucrose	130	107
Thyme oil 50 mg/l + 2% sucrose	125	100
Thyme oil 75 mg/l + 2% sucrose	114	91
Thyme oil 100 mg/l + 2% sucrose	103	83
Black cumin oil 25 mg/l + 2% sucrose	132	117
Black cumin oil 50 mg/l + 2% sucrose	121	97
Black cumin oil 75 mg/l + 2% sucrose	110	88
Black cumin oil 100 mg/l + 2% sucrose	100	80
Rosemary oil 50 mg/l + 4% sucrose	142	110
Rosemary oil 100 mg/l + 4% sucrose	132	106
Rosemary oil 150 mg/l + 4% sucrose	120	96
Rosemary oil 200 mg/l + 4% sucrose	109	88
Ethanol 5 mg/l + 2% sucrose	115	97
Ethanol 10 mg/l + 2% sucrose	111	88
Ethanol 15 mg/l + 2% sucrose	101	80
Ethanol 20 mg/l + 2% sucrose	91	73
Salicylic acid 25 mg/l + 2% sucrose	103	90
Salicylic acid 50 mg/l + 2% sucrose	94	75
Salicylic acid 100 mg/l + 2% sucrose	85	68
Salicylic acid 150 mg/l + 2% sucrose	78	62
Average	**110**	**88**
LSD (0.05)	**3.43**	**3.87**

Protein percentage

Data concerning the effect of some essential oils, ethanol and salicylic acid on dry weight (g) of tuberose cut flowers in the first and second experiments (September and October, 2016), are presented in Table (7). Data showed that, in general treatments of the applied materials resulted in significant increase in protein percentage in comparison with control in both experiments. Furthermore, statistical analysis indicated that, peppermint oil at 150, 200 mg/l, ethanol at 15, 20 mg/l, salicylic acid at 100, 150 mg/l, thyme oil at 100 mg/l and black cumin oil at 100 mg/l in the two experiments were more effective on increasing the percentage of protein than other treatments. These results might be attributed to salicylic acid (SA) effect as an inhibitor of ethylene biosynthesis thereby delaying the senescence process. In addition to

involvement of SA in local and systemic resistance to pathogens, it has been stated that SA suppress the conversion of ACC into ethylene by inhibiting the ACC oxidase activity (Aminocyclo propane carboxylate oxidase). The production of reactive oxygen species suggested as a main signal for alerting and modifying metabolism and gene expression. Based on the available evidences it is obvious that free oxygen radicals are involved in the senescence process via inducing oxidative stress as stated by Danaee *et al.* (2013).

Table (7). Effect of some essential oils, ethanol and salicylic acid on the protein (%) of tuberose cut flowers in the first and second experiments (September and October, 2016)

Treatments	Protein (%)	
	September, 2016	October, 2016
Control	5.55	8.06
Peppermint oil 50 mg/l + 4% sucrose	9.44	10.37
Peppermint oil 100 mg/l + 4% sucrose	10.48	11.52
Peppermint oil 150 mg/l + 4% sucrose	11.64	12.81
Peppermint oil 200 mg/l + 4% sucrose	12.96	14.25
Thyme oil 25 mg/l + 2% sucrose	8.10	8.92
Thyme oil 50 mg/l + 2% sucrose	9.00	9.90
Thyme oil 75 mg/l + 2% sucrose	10.00	11.00
Thyme oil 100 mg/l + 2% sucrose	11.12	12.23
Black cumin oil 25 mg/l + 2% sucrose	8.46	9.31
Black cumin oil 50 mg/l + 2% sucrose	9.39	10.31
Black cumin oil 75 mg/l + 2% sucrose	10.33	11.48
Black cumin oil 100 mg/l + 2% sucrose	11.62	12.77
Rosemary oil 50 mg/l + 4% sucrose	7.64	8.42
Rosemary oil 100 mg/l + 4% sucrose	8.50	9.35
Rosemary oil 150 mg/l + 4% sucrose	9.46	10.39
Rosemary oil 200 mg/l + 4% sucrose	10.52	11.56
Ethanol 5 mg/l + 2% sucrose	8.87	9.44
Ethanol 10 mg/l + 2% sucrose	9.87	10.52
Ethanol 15 mg/l + 2% sucrose	10.98	12.06
Ethanol 20 mg/l + 2% sucrose	12.21	13.41
Salicylic acid 25 mg/l + 2% sucrose	9.77	7.70
Salicylic acid 50 mg/l + 2% sucrose	10.87	11.96
Salicylic acid 100 mg/l + 2% sucrose	12.08	13.29
Salicylic acid 150 mg/l + 2% sucrose	13.44	14.77
Average	**10.09**	**11.03**
LSD (0.05)	**0.77**	**1.75**

Total soluble solids (%)

Data concerning the effect of some essential oils, ethanol and salicylic acid on the total soluble solids in petals of tuberose cut flowers in the first and second experiment (September and October, 2016), are listed in Tables (8 and 9). Data showed that, in general treatments of the applied materials resulted in significant increase in total soluble solids in comparison with control in both experiments. Moreover, peppermint oil at (150 and 200) mg/l, thyme oil at 100

mg/l, black cumin oil at 100 mg/l**,** rosemary oil at 200 mg/l and salicylic acid at (100 and 150) mg/l were more effective on increasing total soluble solids than other treatments.

Table (8). Effect of some essential oils, ethanol and salicylic acid on the total soluble solids (%) of tuberose cut flowers in the first experiment (September, 2016)

Treatments	Total soluble solid (%)			
	Vase life (days)			Average
	Initial Time	5	10	
Control	4.09	3.27	2.61	3.33
Peppermint oil 50 mg/l + 4% sucrose	5.04	4.04	3.22	4.10
Peppermint oil 100 mg/l + 4% sucrose	5.60	4.48	3.58	4.56
Peppermint oil 150 mg/l + 4% sucrose	6.22	4.98	3.98	5.06
Peppermint oil 200 mg/l + 4% sucrose	6.92	5.53	4.42	5.62
Thyme oil 25 mg/l + 2% sucrose	4.67	3.74	2.99	3.80
Thyme oil 50 mg/l + 2% sucrose	5.19	4.16	3.32	4.22
Thyme oil 75 mg/l + 2% sucrose	5.77	4.62	3.70	4.70
Thyme oil 100 mg/l + 2% sucrose	6.41	5.13	4.11	5.22
Black cumin oil 25 mg/l + 2% sucrose	4.86	3.89	3.11	3.95
Black cumin oil 50 mg/l + 2% sucrose	5.40	4.32	3.45	4.39
Black cumin oil 75 mg/l + 2% sucrose	6.00	4.80	3.84	4.88
Black cumin oil 100 mg/l + 2% sucrose	6.67	5.34	4.27	5.43
Rosemary oil 50 mg/l + 4% sucrose	4.55	3.65	2.92	3.71
Rosemary oil 100 mg/l + 4% sucrose	5.06	4.06	3.25	4.12
Rosemary oil 150 mg/l + 4% sucrose	5.62	4.51	3.61	4.58
Rosemary oil 200 mg/l + 4% sucrose	6.25	5.02	4.01	5.09
Ethanol 5 mg/l + 2% sucrose	4.94	3.95	3.16	4.02
Ethanol 10 mg/l + 2% sucrose	5.49	4.39	3.51	4.46
Ethanol 15 mg/l + 2% sucrose	6.10	4.88	3.90	4.96
Ethanol 20 mg/l + 2% sucrose	6.78	5.42	4.34	5.51
Salicylic acid 25 mg/l + 2% sucrose	5.29	4.24	3.39	4.30
Salicylic acid 50 mg/l + 2% sucrose	5.88	4.71	3.76	4.78
Salicylic acid 100 mg/l + 2% sucrose	6.54	5.23	4.19	5.32
Salicylic acid 150 mg/l + 2% sucrose	7.27	5.81	4.65	5.91
Average	**5.71**	**4.60**	**3.70**	
LSD (0.05)	**D: 0.01**	**T: 0.05**	**D×T: 0.08**	
D: Vase Life	**T: Treatments**	**D×T: Interaction**		

Table (9). Effect of some essential oils, ethanol and salicylic acid on the total soluble solid (%) of tuberose cut flowers in the second experiment (October, 2016)

Treatments	Total soluble solid (%)			
	Vase life (days)			Average
	Initial Time	5	10	
Control	4.50	3.75	3.00	3.75
Peppermint oil 50 mg/l + 4% sucrose	5.54	4.43	3.54	4.51
Peppermint oil 100 mg/l + 4% sucrose	6.16	4.92	3.94	5.01
Peppermint oil 150 mg/l + 4% sucrose	6.84	5.47	4.38	5.56
Peppermint oil 200 mg/l + 4% sucrose	7.61	5.75	4.86	6.07
Thyme oil 25 mg/l + 2% sucrose	5.14	4.11	3.29	4.18
Thyme oil 50 mg/l + 2% sucrose	5.72	4.57	3.65	4.65
Thyme oil 75 mg/l + 2% sucrose	6.35	5.08	4.08	5.17
Thyme oil 100 mg/l + 2% sucrose	7.06	5.65	4.52	5.74
Black cumin oil 25 mg/l + 2% sucrose	5.35	4.28	3.39	4.34
Black cumin oil 50 mg/l + 2% sucrose	5.94	4.75	3.77	4.82
Black cumin oil 75 mg/l + 2% sucrose	6.60	5.28	4.19	5.36
Black cumin oil 100 mg/l + 2% sucrose	7.34	5.87	4.69	5.97
Rosemary oil 50 mg/l + 4% sucrose	5.01	4.01	3.20	4.07
Rosemary oil 100 mg/l + 4% sucrose	5.58	4.45	3.56	4.53
Rosemary oil 150 mg/l + 4% sucrose	6.18	4.95	3.95	5.03
Rosemary oil 200 mg/l + 4% sucrose	6.87	5.50	4.39	5.59
Ethanol 5 mg/l + 2% sucrose	5.44	4.34	3.47	4.42
Ethanol 10 mg/l + 2% sucrose	6.04	4.83	3.86	4.91
Ethanol 15 mg/l + 2% sucrose	6.71	5.37	4.29	5.45
Ethanol 20 mg/l + 2% sucrose	7.46	5.96	4.77	6.06
Salicylic acid 25 mg/l + 2% sucrose	5.82	4.66	3.73	4.74
Salicylic acid 50 mg/l + 2% sucrose	6.47	5.18	4.14	5.26
Salicylic acid 100 mg/l + 2% sucrose	7.19	5.75	4.60	5.85
Salicylic acid 150 mg/l + 2% sucrose	7.99	6.39	5.11	6.50
Average	**6.28**	**5.01**	**4.01**	
LSD (0.05)	**D: 0.04**	**T: 0.10**	**D×T: 0.16**	
D: Vase Life	**T: Treatments**	**D×T: Interaction**		

Similar results were obtained by Mohammadi *et al.* (2014) on rose, The positive effect of salicylic acid on decreasing total soluble solids could be attributed to that salicylic acid which considered to be an important signaling molecule which is involved in local and endemic disease resistance in plants in response to various pathogenic attacks. Besides providing disease resistance to the plants, salicylic acid can modulate plant responses to a wide range of oxidative stresses. Salicylic acid also suppressed ACC synthase and ACC oxidase activities and biosynthesis of ethylene, and hence retarded the climacteric rise in ethylene production as proved by Sardoei *et al.* (2013). These findings are in agreement with Jamshidi *et al.* (2012).

As the effect of vase life periods, results indicated that total soluble solids of tuberose cut flowers was decreased with increasing vase life periods and the differences among all tested vase life periods were statistically significant compared with initial time. In agreement with these results, are those obtained

by Eshaghdavatgar *et al.* (2013) on "Dolce Vita" who reported that the pulse treatment of 3% (w/v) sucrose +4% (w/v) $Cacl_2$ in combination with thyme extracts at 0.2 ppm had more positive effects on extending the vase life of cut rose flowers than two control groups or other treatments. Also, Tehranifar *et al.* (2013) indicated that the addition of 300 mg/l salicylic acid to clean distilled water extended the vase life of *Alstroemeria peruviana, Gerbera jamesonii, Lilium asiaticum, Polianthes tuberose* and *Rosa hybrida* by 30 -55 (%) relative to control.

CONCLUSION

In conclusion, the present study demonstrates that all treatments showed significant effect on quality parameters and flowers longevity compared to control in tuberose experiments. Peppermint oil at (150 and 200) mg/l, thyme oil at (75 and 100) mg/l, black cumin oil at 100 mg/l, rosemary oil at 200 mg/l and salicylic acid at (50, 100 and 150) mg/l were more effective in improving the quality parameters than other treatments. The present findings support the need for wider testing and use of the natural, cheap, safe and biodegradable compounds.

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الملخص العربي

عمر أزهار التبروز المقطوفة بإستخدام بعض معاملات ما بعد الحصاد

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تعتبر المحافظة على جودة وعمر الأزهار من العوامل الهامة لتقييم جودة زهور القطف فى كلاً من الأسواق المحلية وأسواق التصدير. تهدف هذه الدراسة إلى تحديد فعالية زيت النعناع بتركيز (٥٠، ١٠٠، ١٥٠، ٢٠٠) مجم/لتر، زيت الزعتر بتركيز (٢٥، ٥٠، ٧٥، ١٠٠) مجم/لتر، زيت الكمون الأسود بتركيز (٢٥، ٥٠، ٧٥، ١٠٠) مجم/لتر، زيت إكليل الجبل بتركيز (٥٠، ١٠٠، ١٥٠، ٢٠٠) مجم/لتر، حامض السلسليك بتركيز (٢٥، ٥٠، ١٠٠، ١٥٠) مجم/لتر ومعاملة الكنترول (معاملة الأزهار بالماء المقطر فقط) على معايير الجودة لأزهار التبروز المقطوفة. أظهرت النتائج أن كل المعاملات أدت إلى زيادة معنوية فى عمر الأزهار والوزن الطازج و كمية الماء الممتص والبروتين المتراكم والمواد الصلبة الذائبة مع خفض عدد البكتريا مقارنة بالكنترول. هذا بالأضافة إلى أن معاملات زيت النعناع بتركيز ٢٠٠ مجم/لتر، زيت الزعتر بتركيز ١٠٠ مجم/لتر، زيت الكمون الأسود بتركيز ١٠٠ مجم/لتر، زيت إكليل الجبل بتركيز ١٠٠ مجم/لتر وحامض السالسليك بتركيز (١٠٠ ، ٢٠٠) مجم/لتر كانت أكثر تأثيراً فى تحسين صفات جودة أزهار التبروز أو مسك الروم المقطوفة مقارنة بباقى المعاملات.