Annals of Phytomedicine 15(1): 763-772, 2026

DOI: http://dx.doi.org/10.54085/ap.2026.15.1.69

Annals of Phytomedicine: An International Journal

http://www.ukaazpublications.com/publications/index.php

Print ISSN : 2278-9839 Online ISSN : 2393-9885

Original Article : Open Access

Effectiveness of essential oils in maintaining quality and display life of cut Chrysanthemum (*Dendranthema grandiflora*) cv. Arctic Queen

A. Nirmala*◆, A. Manohar Rao*, P. Prasanth, S. Narendar Reddy* and D. Srinivasachary*****

** Telanagana Rythu Vignana Kendram, Sangupet, Sangareddy-5022273, Professor Jayasankar, Telanagana Agricultural University, Telangana, India*

*** College of Horticulture, Sri Konda Laxman Telangana Horticultural University, Rajendranagar-500030, Hyderabad, Telangana, India*

**** Department of Agricultural Statistics, Agricultural Engineering College, Kandi, Sangareddy-502285, Telangana, India*

Article Info

Article history

Received 6 April 2026

Revised 14 May 2026

Accepted 15 May 2026

Published Online 30 June 2026

Keywords

Chrysanthemum

Sucrose

Essential oils

Display life

Abstract

The present study evaluated the influence of different essential oils; namely, Artemisia, Ocimum, Geranium, and Rosemary, each at 2.5% and 5% concentrations, on the display life of cut Chrysanthemum cv. Arctic Queen after pulsing with 10% sucrose. The results clearly indicated that the vase solution containing 2.5% geranium oil was the most effective treatment in maintaining flower freshness and prolonging the acceptable display life of Chrysanthemum flowers. Flowers treated with this concentration retained their ornamental value for a longer period compared with the other treatments.

The beneficial effect of 2.5% geranium oil may be primarily attributed to its ability to enhance water uptake and maintain a better water balance within the flower tissues. Adequate water absorption helps in sustaining petal turgidity, preventing wilting, and delaying visible symptoms of senescence. In addition, higher water retention in the petals helps the flowers remain fresh, firm, and visually attractive for a longer duration. Geranium oil may also possess antimicrobial properties, which could reduce microbial growth in the vase solution and prevent blockage of xylem vessels. This ensures continuous water movement through the stem, thereby supporting better hydration of the flowers.

Furthermore, the combination of 10% sucrose pulsing and 2.5% geranium oil may have contributed to improved post-harvest performance. Sucrose serves as an energy source for maintaining metabolic activities, while geranium oil helps in preserving water relations and delaying deterioration. Therefore, the extended display life observed under 2.5% geranium oil treatment can be associated with improved water uptake, enhanced petal water retention, delayed wilting, and better maintenance of overall flower freshness and quality.

1. Introduction

As a leading commercial crop second to Rose, Chrysanthemum (*Dendranthema grandiflora*) requires specialised post-harvest care to maintain quality. Once cut, the flowers continue to respire and transpire, leading to rapid senescence and reduced market value. Therefore, suitable post-harvest treatments are essential to delay ageing and extend display life (Tsegaw *et al*., 2011).

The shorter display life of cut flowers is a major bottleneck in the floriculture industry, often addressed by using vase solutions with preservatives to prolong freshness. Recently, essential oils have emerged as promising natural alternatives due to their significant antioxidant and antimicrobial properties (Basak and Guha, 2018). These oils act as antimicrobials through their bioactive constituents, which disrupt microbial cell membranes. Their hydrophobic components interact with membrane lipids, causing leakage of cellular contents, metabolic failure, and eventual cell death (Silva *et al*., 2021).

Corresponding author: Dr. A. Nirmala

Scientist (CP), Telangana Rythu Vignana Kendram, Sangupet, Sangareddy-5022273, Telangana, India

E-mail: nirmala.puli@gmail.com

Tel.: +91-8330940330

Essential oils play an important role in cut flower preservation by reducing microbial proliferation in vase solutions and at the cut stem ends. Microbial blockage of xylem vessels is one of the major causes of poor water uptake in cut flowers, which results in wilting, loss of turgidity, petal discolouration, and early senescence. By suppressing bacterial and fungal growth, essential oils help maintain the continuity of water absorption through the stem, thereby improving flower freshness and extending vase life. In addition, many essential oils contain phenolic compounds and other secondary metabolites that possess antioxidant activity, which helps reduce oxidative stress and membrane deterioration in floral tissues. This contributes to delayed petal senescence and better retention of flower colour, texture, and overall ornamental quality.

The usage of essential oils in cut flower preservation mainly involves their incorporation into vase solutions or holding solutions at suitable concentrations. Oils such as Geranium, Rosemary, Ocimum, Artemisia, Thyme, Clove, and Lemongrass have been reported to improve the keeping quality of cut flowers by acting as natural antimicrobial agents (Bassole and Juliani, 2012). Their effectiveness depends on the type of oil, concentration used, flower species, and duration of treatment. When used at optimum concentrations, essential oils can function as natural preservatives, either alone or in combination with sucrose and other holding solution components.

Sucrose provides an energy source for the cut flowers, while essential oils help maintain water uptake by controlling microbial contamination. Thus, the combined use of sugars and essential oils can improve post-harvest performance and display life.

The keeping quality of flowers after purchase greatly influences consumer satisfaction. Flowers that retain their freshness, fragrance, and visual appeal for a longer period are more likely to encourage repeated purchase. Therefore, there is a strong need to identify safe and effective methods for prolonging display life using preservatives, antioxidants, and antitranspirants. It has been reported that nearly 30-40% of flower losses occur because of improper postharvest handling throughout the marketing chain (Singh and Tiwari, 2002). Although, several chemical preservatives are available, many of them are costly and may also pose risks to human health, including irritation of the skin, eyes, and respiratory tract.

In this context, essential oils offer a promising, eco-friendly alternative. Being natural organic substances, they are considered safer and more environmentally acceptable, while also showing strong antimicrobial activity against a range of pathogens. These effects are often linked to the presence of phenolic compounds in high concentrations (Lambert *et al*., 2001; Mihajilov-Krstev *et al*., 2010). By suppressing microbial growth in vase solutions, maintaining stem hydraulic conductance, reducing oxidative damage, and delaying senescence, essential oils can significantly improve the display life and marketability of cut flowers (Burt, 2004). Therefore, their use represents a sustainable approach for post-harvest management in Chrysanthemum and other commercially important cut flowers.

2. Materials and Methods

2.1 Plant authentication and description of Chrysanthemum cv. Arctic Queen release

Chrysanthemum (*Dendranthema grandiflora*) cv. Arctic Queen flowers were obtained from commercial farm, located at Ravulavaripalle Village in Chevella Mandal, Rangareddy, Telangana, India. Specimens were authenticated by Dr. A. Manohar Rao, Retd. Professor and Head of Department of Horticulture, College of Agriculture, Professsor Jayasankar Telanagana Agricultural University, Rajendranagar, Hyderabad, India.

Chrysanthemum cv. Arctic Queen is a spray-type, white-coloured cultivar, developed by the Dutch Breeding Company Fides (now in Dummen Orange) in de Lier, The Netherlands (FCC, 2010) with PBR number (23a).

Chrysanthemum cv. 'Arctic Queen' is a popular, commercially significant white spray-type cultivar, widely recognized in the floral industry for its elegant appearance and robust, multi-headed, pure white flowers with green centers. It is primarily cultivated as a high-quality cut flower, known for its use in protected, year-round, or off-season commercial greenhouse production. It is often used in research for its desirable traits in commercial cut flower markets, including in high environmental studies.

2.2 Preparation of Chrysanthemum flowers

The cut stems generally measure 65-70 cm in length, while the flower heads are about 6-8 cm in diameter. Chrysanthemum (*Dendranthema grandiflora)* cv. Arctic Queen is a spray-type cultivar characterised by multiple flower heads. It produces attractive white blooms with a green centre, which enhances its ornamental value and market demand.

2.3 Preparation of solutions

Artemisia oil, Ocimum oil, Geraniol, and Rosemary oil were tested at 2.5% and 5% concentrations. For preparing these solutions, 25 ml and 50 ml of each oil were first dissolved in ethyl alcohol. Triton X-100 was then added to ensure complete solubilization of the oils, and the final volume was adjusted to one litre with distilled water.

2.4 Pulsing

In this experiment, all treatments were pulsed for four hours with a 10% sucrose solution, identified as the most effective treatment in the first experiment, and were then transferred to essential oil solutions of different concentrations for display life evaluation, except for the control.

2.5 Holding

The flowers were continuously held in the treatment solutions till the end of the vase life period and vase life was defined as days from time of immersion in the test solution to the loss of ornamental value, like stem bending, blackening, wilting and abscission of petals. The experiments were repeated twice for confirmation of the results. Display life was determined by recording the number of days until 50% of the flowers in each replication showed signs of spoilage (wilting, abscission, or loss of turgidity), following the method of Abadi *et al*. (2013).

2.6 Treatment details of the experiment

T1-Artemisia oil 2.5%

T2 -Artemisia oil 5%

T3 -Ocimum oil 2.5%

T4 -Ocimum oil 5%

T5 - Geranium oil 2.5%

T6 - Geranium oil 5%

T7 - Rosemary oil 2.5%

T8 - Rosemary oil 5%

T9- Control (Distilled water)

Total number of treatments = 9

Number of replications = 3

Number of flowers per replication = 10

Design = Completely Randomised Design with Factorial concept

2.7 Statistical analysis

The experiment included three replications of each treatment. The design adopted was a completely randomised design with factorial concept, and the data were subjected to statistical analysis as per the procedure outlined by Panse and Sukhatme (1978). Results on vase life experiments were analysed using analysis of variance (ANOVA) and F-test analysis. Significant difference (CD) was used for the comparison between treatments during vase life. Based on the F-test, the non-significant (NS) values were ignored in the description of results.

Figure 1: Flowers kept in different essential oil solutions for display life studies.

3. Results

3.1 Flower weight (g)

Essential oil application had a significant influence on the fresh weight of cut Chrysanthemum flowers. This indicates that the treatments played an important role in maintaining the water status and freshness of the flowers during the display period. Among the different treatments, T5 recorded the highest fresh weight of 5.71 g, showing its superior effect in preserving flower fresh weight. In contrast, T9 recorded the lowest fresh weight of 4.78 g. However, the fresh weight recorded in T9 was statistically on par with T1 (4.96 g) and T2 (4.92 g), indicating that these treatments showed a relatively similar effect on maintaining flower weight. The fresh weight of cut Chrysanthemum flowers also varied significantly with the advancement of the display life period. The fresh weight increased from the 2nd day to the 4th day, reaching the maximum mean value of 5.74 g on the 4th day. After the 4th day, a gradual decline in fresh weight was observed. The fresh weight decreased to 5.05 g on the 6th day and further declined to 4.52 g by the 10th day.

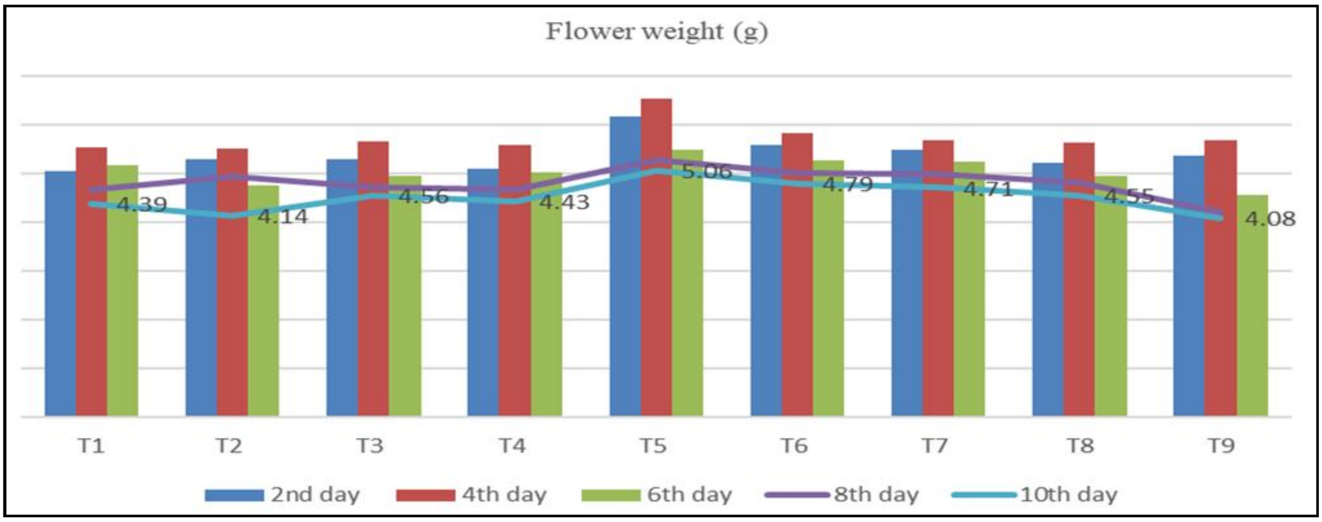

Figure 2: Effect of essential oils on flower weight (g) of cut Chrysanthemum cv. Arctic Queen.

3.2 Flower diameter (cm)

Essential oil treatments exerted a significant influence on the flower diameter of cut Chrysanthemum cv. Arctic Queen, indicating their role in maintaining flower expansion, petal turgidity, and overall visual quality during the display life period. Among the different treatments, T5 recorded the maximum flower diameter of 5.4 cm, reflecting its superior effectiveness in preserving the size and freshness of the flowers. This treatment was found to be statistically at par with T6 (5.1 cm), T7 (5.1 cm), T3 (5.0 cm), and T8 (5.0 cm) suggesting, that these treatments also performed reasonably well in maintaining flower diameter. In contrast, T9 recorded the minimum flower diameter of 4.7 cm, indicating comparatively poor maintenance of flower expansion. The remaining treatments exhibited intermediate values, showing moderate effectiveness in sustaining flower size.

The flower diameter also varied significantly throughout the display life period under the influence of different essential oil solutions. During the initial stages of display, the flowers maintained better expansion, while a gradual reduction in flower diameter was observed as the display period advanced.

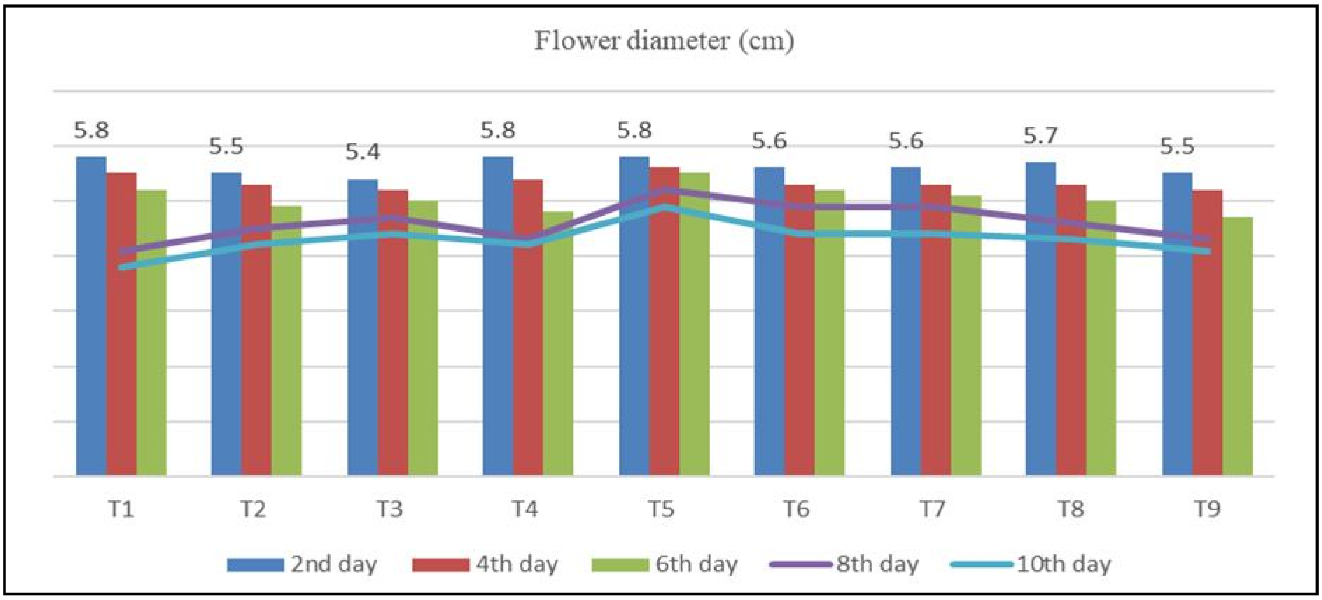

Figure 3: Effect of essential oils on flower diameter (g) of cut Chrysanthemum cv. Arctic Queen.

3.3 Water uptake (g/f)

Significant differences were observed in the water uptake of cut Chrysanthemum flowers cv. Arctic Queen ia influenced by different essential oil treatments. This indicates that the composition of the vase solution played an important role in maintaining hydration and post-harvest quality of the flowers. Among the treatments, T5 recorded the highest water uptake of 16.39 g/flower, showing its superior efficiency in promoting absorption of the vase solution by the cut stems. This treatment was found to be statistically at par with T6 (15.81 g/flower), indicating that both treatments were effective in improving water uptake. In contrast, T2 recorded the lowest water uptake of 12.05 g/flower, indicating relatively poor absorption of the vase solution. The remaining treatments showed intermediate values, reflecting moderate effectiveness in maintaining water uptake. Water uptake also varied significantly during the display life period. During the initial stages, water uptake increased from 15.34 g on the 2nd day to the maximum value of 17.18 g on the 4th day. However, after the 4th day, water uptake declined gradually and reached 9.38 g by the 10th day.

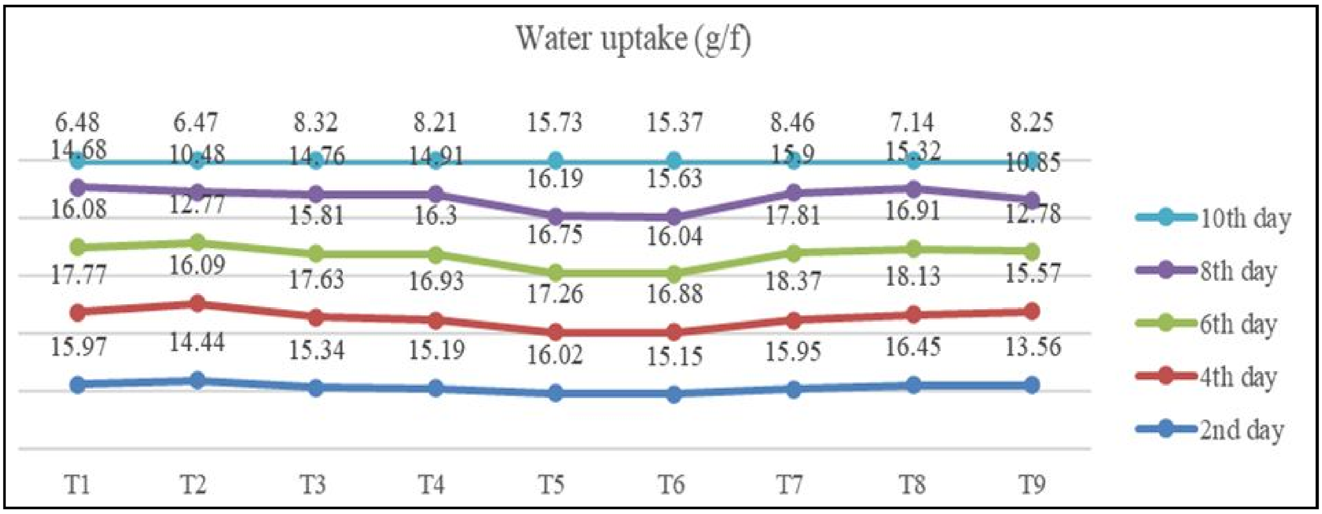

Figure 4: Effect of essential oils on water uptake of cut Chrysanthemum cv. Arctic Queen.

3.4 Transpiration loss of water (g/f)

The cut Chrysanthemum flowers maintained in different essential oil vase solutions exhibited significant variation in transpiration loss of water (TLW), indicating that the treatments had a marked influence on water movement and physiological activity during the display period. Among the treatments, T5 recorded the highest transpiration loss of water of 12.31 g/flower. This treatment was found to be statistically on par with T6 (12.05 g/flower), T7 (11.91 g/flower) and T8 (11.90 g/flower), suggesting that these treatments maintained comparatively higher water movement through the floral tissues. In contrast, T9 recorded the lowest TLW of 10.95 g/flower, while the remaining treatments showed intermediate values. Transpiration loss of water also increased significantly with the advancement of the display life period. The TLW increased gradually from 10.11 g/flower on the 2nd day to 13.11 g/flower on the 10th day. It was also evident from Figure 5 that all essential oil treatments recorded higher transpiration loss of water compared to the control, indicating that essential oils were effective in maintaining active water movement in cut Chrysanthemum flowers.

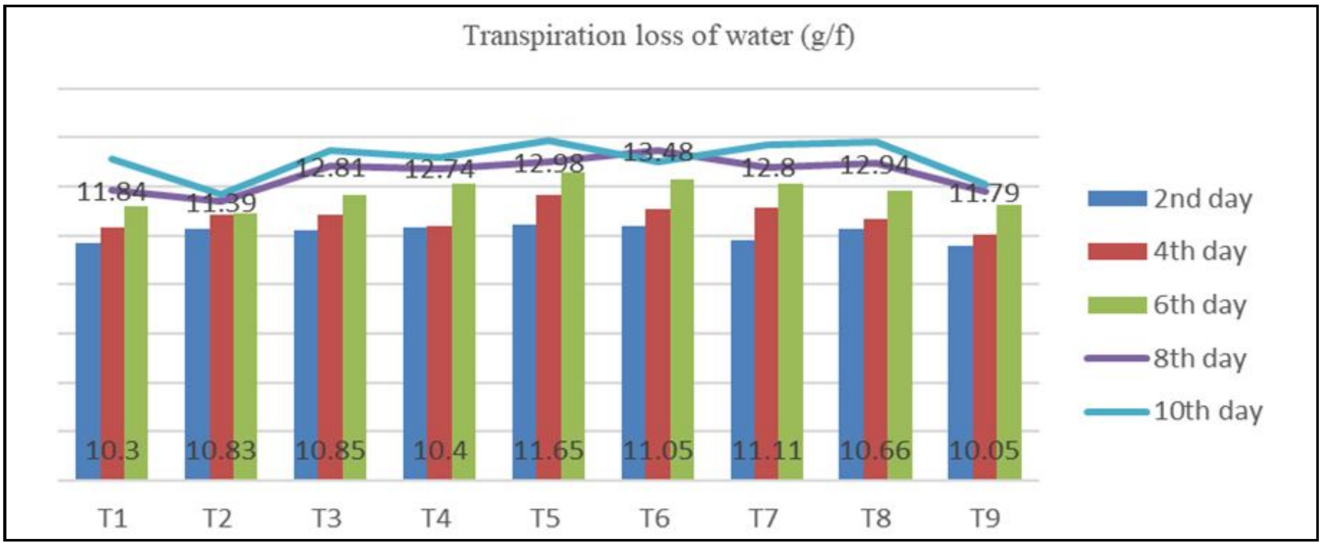

Figure 5: Effect of essential oils on TLW of cut Chrysanthemum cv. Arctic Queen.

3.5 Fresh weight change (g)

Significant variation was observed in the fresh weight change of cut Chrysanthemum flowers under different essential oil treatments. This indicates that the treatments had a marked influence on maintaining flower freshness, hydration status, and post-harvest quality. Among the treatments, T5 recorded the maximum fresh weight change value of 95.82 g, showing its superior effectiveness in sustaining flower weight during the display period. This treatment was found to be statistically at par with T6 (93.32 g), T7 (92.75 g), and T8 (90.93 g), suggesting that these treatments also performed well in maintaining the fresh condition of the flowers. In contrast, T2 recorded the lowest value of 81.59 g, while the remaining treatments showed intermediate responses. Fresh weight changes also differed significantly throughout the display life period. A progressive decline in flower weight was observed as the display period advanced, with fresh weight decreasing from 97.42 g on the 2nd day to 76.38 g by the 10th day.

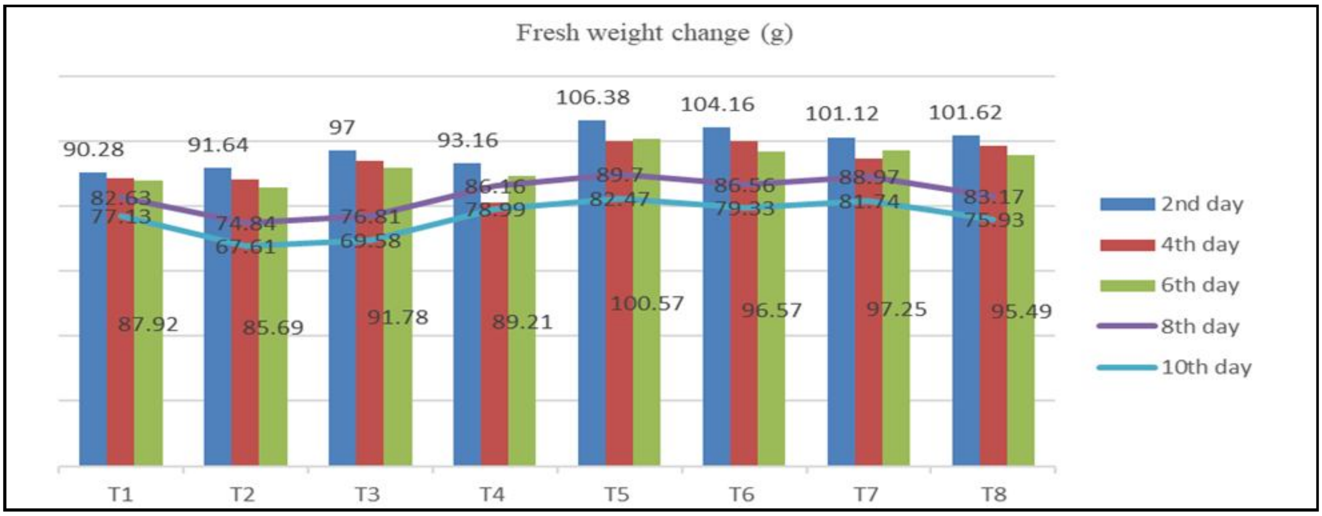

Figure 6: Effect of essential oils on FWC of cut Chrysanthemum cv. Arctic Queen.

3.6 Relative water content (%)

Significant variations were observed in the relative water content (RWC) of petals among the different essential oil treatments, indicating that the treatments had a clear influence on the hydration status and physiological freshness of cut Chrysanthemum flowers. Among the treatments, T5 recorded the highest petal RWC of 82.29%, followed by T6 with 79.52%, showing that these treatments were more effective in maintaining moisture within the petal tissues. In contrast, T9 recorded the lowest RWC of 72.97%, suggesting comparatively poor water retention and greater tissue dehydration. The remaining treatments showed intermediate values. Relative water content also varied significantly during the display life period. A gradual decline in RWC was observed as the flowers aged, decreasing from 84.80% on the 2nd day to 68.07% by the 10th day.

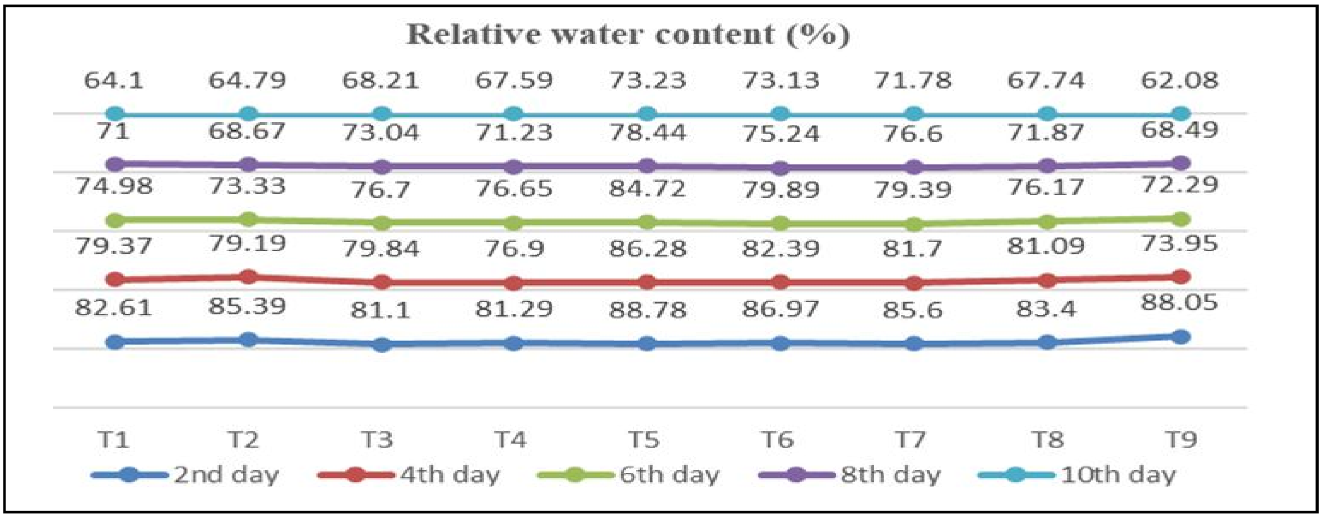

Figure 7: Effect of essential oils on RWC of cut Chrysanthemum cv. Arctic Queen.

3.7 Electrolyte leakage (%)

The cut Chrysanthemum flowers exhibited significant differences in electrolyte leakage under the influence of different essential oil treatments. This indicates that the treatments varied in their ability to maintain membrane stability and delay tissue deterioration during the display period. Among the treatments, T4 recorded the highest electrolyte leakage of 89.31%, suggesting greater membrane damage and faster loss of cellular integrity. In contrast, T5 recorded the lowest electrolyte leakage of 78.49%, indicating better preservation of cell membrane stability and reduced physiological stress.

The remaining treatments showed intermediate levels of electrolyte leakage. Electrolyte leakage also varied significantly with the advancement of display life. A gradual increase was observed from 71.15% on the 2nd day to 93.49% by the 10th day. This indicates that membrane damage increased progressively as the flowers aged.

Table 1: Effect of essential oils on EL of cut Chrysanthemum cv. Arctic Queen

Treatments	2nd day	4th day	6th day	8th day	10th day	Mean
T1 - Artemisia oil 2.5%	73.42	81.14	83.90	87.22	92.74	83.68
T2 - Artemisia oil 5%	72.86	81.13	86.11	88.04	92.68	84.17
T3 - Ocimum oil 2.5%	71.21	76.73	82.80	88.32	93.84	82.58
T4 - Ocimum oil 5%	81.14	86.11	90.53	92.18	96.68	89.31
T5 - Geranium oil 2.5%	67.34	70.66	77.83	85.56	91.08	78.49
T6 - Geranium oil 5%	69.00	75.07	81.14	87.22	91.63	80.81
T7 - Rosemary oil 2.5%	69.06	71.21	78.94	89.98	96.05	81.03
T8 - Rosemary oil 5%	63.48	67.34	86.66	91.18	96.60	81.05
T9 - Control (Distilled water)	72.86	78.00	82.98	86.17	90.20	82.04
Mean	71.15	76.38	83.43	88.42	93.49	82.57
F test	SE		**CD (0.01)**			
Treatment (T)	**		**1.13**		**4.20**	
Days (D)	**		**0.84**		**3.13**	
T × D	*		**2.52**		**7.09**	

** Significant at ($p \leq 0.01$) * Significant at ($p \leq 0.05$) NS: Not significant.

3.8 Display life (days)

The display life of cut Chrysanthemum flowers varied significantly among the different vase solution treatments, indicating that the composition of the holding solution had a considerable influence on post-harvest longevity and flower quality. Among the treatments, T5 recorded the longest display life of 8.98 days, demonstrating its superior effectiveness in extending the vase life of cut Chrysanthemum flowers. This treatment was found to be statistically on par with T6 (8.88 days), T7 (8.81 days), T8 (8.82 days), and T9 (8.94 days), suggesting that these treatments also contributed positively to prolonging flower freshness and maintaining display quality. In contrast, the shortest display life was recorded in T3 (7.50 days), which was statistically on par with T4 (7.78 days), T1 (7.94 days), and T2 (8.00 days). These treatments showed comparatively lower effectiveness in delaying senescence and maintaining the ornamental value of the flowers. As indicated in Table 2, pulsing with 10% sucrose followed by holding in geranium oil at 2.5% concentration proved to be the most effective treatment, resulting in a display life of approximately 8.98 days.

Table 2: Effect of essential oils on display life of cut Chrysanthemum cv. Arctic Queen

Treatments	Display life (Days)
T1 - Artemisia oil 2.5%	7.94
T2 - Artemisia oil 5%	8.00
T3 - Ocimum oil 2.5%	7.50
T4 - Ocimum oil 5%	7.78
T5 - Geranium oil 2.5%	8.98
T6 - Geranium oil 5%	8.88
T7 - Rosemary oil 2.5%	8.81
T8 - Rosemary oil 5%	8.82
T9 - Control (Distilled water)	8.34
Mean	8.32
F test	**
SE	**0.20**
CD (0.01)	**0.87**

Significant at ($p \leq 0.01$) * Significant at ($p \leq 0.05$) NS: Not significant.

4. Discussion

The higher fresh weight recorded in T5 may be attributed to better uptake of the vase solution and improved maintenance of water balance in the flower tissues. Essential oil treatments may have helped in reducing microbial growth in the vase solution and stem ends, thereby minimising blockage of xylem vessels and allowing better water absorption. The initial increase in fresh weight up to the 4th day may be due to active uptake of vase solution by the cut flower stems during the early stage of display life. However, the gradual decline in fresh weight after the 4th day may be due to reduced water absorption, increased transpiration, blockage of xylem vessels, and progressive senescence of floral tissues. Similar findings were reported earlier in cut Gerbera and Rose treated with essential oils by Solgi *et al*. (2009); Shanan (2012); Bhanumurthy (2013). The present results are also in agreement with El-Sayed and El-Ziat (2021), who reported that thyme oil at 500 mg/l reduced bacterial counts in cut Chrysanthemums, thereby helping to maintain water uptake and flower freshness.

The superior flower diameter recorded in T5 may be attributed to better maintenance of water relations within the cut flowers. Geranium oil at 2.5% concentration, as shown in Figure 3, proved to be the most effective treatment in maintaining a larger flower diameter in cut Chrysanthemum cv. Arctic Queen. This beneficial effect may be due to the ability of geranium oil to reduce microbial growth in the vase solution and at the cut stem base. By minimising microbial multiplication, geranium oil may have helped prevent xylem blockage and improves continuous water absorption by the flower stems. Better water uptake would have enhanced moisture retention in the petals, maintained cell turgidity, and delayed petal wilting and shrinkage. In contrast, reduced water absorption, increased moisture loss, microbial blockage of vascular tissues, and natural senescence may have contributed to the reduction in flower diameter during the later stages of display life. Thus, the larger flower diameter observed under T5 can be associated with improved hydration, better maintenance of petal freshness, and delayed senescence. Since flower diameter is an important quality parameter directly related to ornamental value, market appeal, and consumer preference, the application of geranium oil at 2.5% can be considered an effective, eco-friendly treatment for improving the post-harvest quality and display life of cut Chrysanthemum flowers.

The increase in water uptake during the early stage of display life may be attributed to active absorption of the vase solution by the freshly cut stems and the maintenance of open vascular tissues. However, the gradual decline in water uptake after the 4th day may be due to progressive senescence, microbial proliferation in the vase solution, blockage of xylem vessels, formation of air embolisms, and reduced physiological activity of the cut flowers. As illustrated in Figure 4, geranium oil at 2.5% concentration was identified as the most effective treatment for enhancing water uptake in cut Chrysanthemum flowers. The superior performance of this treatment may be due to the combined effect of sucrose and geranium oil in the vase solution. Sucrose acts as an important energy source for respiration and helps maintain the metabolic activity of cut flowers. It also supports petal expansion, delays senescence, and helps maintain the freshness and ornamental quality of the flowers. In addition, the antibacterial activity of geranium oil may have played a major role in improving water uptake. Microbial growth in the vase solution and at the cut stem ends is one of the major causes of vascular blockage in cut flowers. Such blockage restricts the movement of water through the xylem vessels and leads to reduced water uptake, loss of turgidity, wilting, and early senescence. Geranium oil, due to its antimicrobial properties, may have minimised microbial multiplication in the vase solution and prevented occlusion of vascular tissues. It may also have helped reduce air embolism formation, thereby maintaining better continuity of water movement through the stem. The higher water uptake recorded under T5 ultimately contributed to better hydration of floral tissues, improved petal turgidity, larger flower diameter, delayed wilting, and prolonged display life. These results clearly indicate that geranium oil at 2.5% concentration was highly effective in maintaining the water balance of cut Chrysanthemum flowers. Similar observations were reported by Solgi *et al*. (2009) in Gerbera cv. Dure, Bayat *et al*. (2011) in Carnation, Shanon (2012) in Rose cv. Grand, and Bhanumurthy

(2013) in Gerbera cv. Savannah, where essential oil-based vase solutions improved water uptake and extended the vase life of cut flowers.

The progressive increase in transpiration loss of water during the display period may be associated with continued water movement from the vase solution through the stem and floral tissues, followed by loss of water from the flower surface. As the flowers aged, petal expansion, increased physiological activity, and senescence-related changes may have contributed to higher transpiration loss during the later stages of display life. As presented in Figure 5, the treatment containing geranium oil at 2.5% concentration recorded the maximum TLW. The superior response under this treatment may be attributed to the presence of active phenolic compounds and other bioactive constituents in geranium oil, which may have helped in regulating metabolic activity and maintaining better water relations in the cut flowers. Geranium oil may also have reduced microbial growth in the vase solution and at the cut stem ends, thereby minimising vascular blockage and improving water uptake. Enhanced absorption of water would support greater movement of water through the floral tissues, resulting in higher transpiration loss. Although, higher transpiration loss generally indicates greater water loss, in this case, it may also reflect better water uptake and continued physiological activity of the flowers treated with essential oils. The ability of T5 to maintain higher TLW, along with improved water uptake and freshness, suggests that geranium oil at 2.5% helped sustain the water balance of cut Chrysanthemum flowers and delayed wilting. This improved water status may have contributed to better petal turgidity, flower opening, and prolonged vase life. These findings are in conformity with the observations of Bhanumurthy (2013) in cut Gerbera flowers, who reported improved water relations and enhanced vase life under essential oil treatments. Thus, geranium oil at 2.5% proved to be the most effective treatment in supporting water uptake, maintaining physiological activity, and extending the display quality of cut Chrysanthemum flowers.

The gradual reduction in fresh weight change during the display period may be attributed to natural senescence, reduced water absorption, increased transpiration, and progressive loss of tissue turgidity during storage and display. As the flowers aged, blockage of xylem vessels, microbial growth in the vase solution, and declining metabolic activity may have further reduced the ability of the stems to absorb and transport water effectively. As indicated in Figure 6, geranium oil at 2.5% concentration proved to be the most effective treatment in maintaining higher fresh weight change in cut Chrysanthemum flowers. The superior performance of this treatment may be mainly due to greater water uptake in relation to transpirational water loss, which helped maintain a favourable water balance within the floral tissues. When water absorption exceeds or adequately compensates for water loss through transpiration, the flowers are able to retain better turgidity, freshness, and structural firmness. The improved fresh weight under geranium oil treatment may also be attributed to the bioactive constituents present in the essential oil, which may have helped reduce microbial proliferation in the vase solution and at the cut stem ends. By minimizing vascular blockage and water stress, geranium oil may have enhanced continuous water absorption and movement through the stem. This improved hydration status would have delayed wilting, reduced petal shrinkage, and maintained the overall appearance and quality of the flowers for a longer period. Thus, the results clearly suggest that geranium oil at 2.5% was highly effective in preserving fresh weight change by improving water uptake, reducing water stress, and maintaining better moisture balance in cut Chrysanthemum flowers during the display life period.

The gradual reduction in relative water content during the display period may be attributed to progressive senescence, reduced water uptake, increased transpiration, and loss of cellular turgidity in the petals. As the display life advanced, microbial blockage in the vascular tissues and declining physiological activity may have further restricted water movement to the flower head, resulting in dehydration of petal tissues. As shown in Figure 7, the application of geranium oil at 2.5% concentration was the most effective treatment in maintaining the highest relative water content in the petals of cut Chrysanthemum flowers. The superior performance of this treatment may be due to the combined effect of 10% sucrose pulsing and geranium oil. Sucrose acts as an important respiratory substrate, providing energy required for continued metabolic activity, petal expansion, and maintenance of cell integrity after harvest. At the same time, geranium oil may have enhanced water uptake by reducing microbial growth in the vase solution and preventing blockage of the xylem vessels. Improved water absorption, along with better moisture retention in petal tissues, helped maintain higher cell turgidity and delayed wilting. In contrast, control flowers experienced greater physiological stress, poor hydration, and faster loss of petal freshness, resulting in lower RWC. Therefore, the higher RWC recorded under T5 clearly indicates that 2.5% geranium oil maintained superior water status, reduced dehydration stress, and prolonged the freshness of cut Chrysanthemum cv. Arctic Queen. These findings support the view of Abbaszadeh *et al*. (2008), who reported that relative water content is an important indicator of a plant's ability to maintain hydration under stress conditions. Hence, maintaining higher RWC through suitable vase solution treatments is essential for improving the quality, appearance, and vase life of cut flowers.

The gradual increase in electrolyte leakage during the display period may be attributed to progressive senescence, breakdown of cellular membranes, increased oxidative stress, and loss of membrane permeability control. Higher electrolyte leakage during the later stages reflects greater cellular damage, reduced freshness, and deterioration of cut flower quality. As presented in Table 1, geranium oil at 2.5% concentration was the most effective treatment in reducing electrolyte leakage in cut Chrysanthemum flowers. The lower leakage observed under this treatment suggests that geranium oil helped maintain membrane integrity by reducing water stress, improving hydration, and possibly limiting microbial activity in the vase solution. Better water uptake and reduced physiological deterioration under geranium oil treatment may have contributed to delayed senescence and improved post-harvest quality. The improved membrane stability under T5 indicates better maintenance of cellular structure and reduced leakage of electrolytes from the petal tissues. On the other hand, flowers held in ocimum oil at 2.5% concentration recorded the highest electrolyte leakage, indicating comparatively greater membrane injury and lower effectiveness in maintaining cellular stability. Overall, the results clearly show that geranium oil at 2.5% was superior in minimising electrolyte leakage, preserving membrane stability, and maintaining the quality of cut Chrysanthemum flowers during the display life period (Monika and Danuta, 2012).

The reduced display life observed in treatments such as T3, T4, T1, and T2 may be due to faster depletion of stored carbohydrates, poor water uptake, microbial blockage of vascular tissues, increased membrane deterioration, and early wilting of petals. The superior performance of T5 may be attributed to the combined beneficial effects of 10% sucrose pulsing and 2.5% geranium oil. Sucrose likely served as an important respiratory substrate, supplying energy required for continued metabolic activity, petal expansion, and delayed senescence after harvest. This energy supply may have helped maintain petal turgidity, freshness, and overall flower appearance for a longer period. The beneficial effect of geranium oil at 2.5% may also be associated with its antimicrobial properties. Microbial growth in vase solutions is a major cause of xylem blockage, which restricts water uptake and accelerates wilting. Geranium oil may have reduced microbial proliferation in the vase solution and at the cut stem ends, thereby maintaining better water absorption and transport through the vascular tissues. Improved water uptake would have helped preserve cellular hydration, maintain tissue firmness, and delay visible symptoms of senescence. Furthermore, the extended display life under T5 may be linked to improved maintenance of cell membrane integrity and reduced sensitivity of the flowers to ethylene during storage. By protecting membrane stability and reducing physiological stress, geranium oil could have slowed the deterioration of floral tissues. As a result, flowers treated with 10% sucrose pulsing followed by 2.5% geranium oil retained better freshness, petal quality, and ornamental value compared to other treatments.

Overall, the results clearly indicate that geranium oil at 2.5% concentration, when used after 10% sucrose pulsing, was the most effective vase solution treatment for extending the display life of cut Chrysanthemum cv. Arctic Queen. This treatment can therefore be considered a promising eco-friendly alternative for improving the post-harvest performance and marketability of cut Chrysanthemum flowers. Top of Form

5. Future scope

Future studies should investigate the efficacy of essential oils as display solutions for cut Chrysanthemum under varying storage temperatures. To enhance quality during long-distance transport, research should focus on the interaction between packaging materials and ventilation levels following pulsing and holding treatments. Furthermore, integrating locally available preservatives with essential oils holds promise for safer, high-quality preservation. Finally, histological and anatomical analyses, specifically regarding xylem water uptake, are necessary to elucidate the mechanism behind the improved display life provided by essential oils.

6. Conclusion

The present study showed that essential oils extracted from Artemisia, Ocimum, Geranium, and Rosemary were effective in maintaining flower quality and extending the display life of cut Chrysanthemum cv. Arctic Queen. Among the different oils evaluated, geranium oil proved to be the most effective, followed by Rosemary oil, Ocimum oil, and Artemisia oil. The beneficial effects of these essential oils may be attributed to their active constituents, which helped suppress microbial growth in the vase solution and at the cut stem ends of the flowers. Among all the treatments, geranium oil at 2.5% was found to be the most effective concentration. This treatment recorded the longest display life (8.98 days), which may be due to better maintenance of water balance in the cut flowers, reduced sensitivity to ethylene, and the antibacterial properties of geranium oil.

Acknowledgments

I sincerely thank the College of Horticulture, Sri Konda Laxman Telangana Horticultural University, Rajendranagar, for providing the necessary infrastructure, technical support, and continuous encouragement that facilitated the successful execution of this research work. I thank my chairman and committee members for their support.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

References

Abadi, M. A. R. H.; Moghadam, A. R. L. and Abdossi, V. (2013). The affected postharvest life of Gerbera cut flowers by the application of silver nitrate, silver thiosulfate and nano silver. International Research Journal of Applied and Basic Sciences, **4**(4):806-809.

Abbaszadeh, B.; Sharifi Ashourabadi, E.; Lebaschi, M. H,; Hajibagher Kandy, M. N. and Moghadami, F. (2008). The effect of drought stress on proline contents, soluble sugars, chlorophyll and relative water contents of balm (*Melissa officinalis* L.). Iranian J. of Med. and Arom. Plants, **23**:504-513.

Bassole, I.H.N. and Juliani, H.R. (2012). Essential oils in combination and their antimicrobial properties. Molecules, **17**(4):3989-4006.

Bhanumurthy, K.C. (2013). Studies on the effect of post-harvest treatments and floral preservatives on the extension of display life of cut Gerbera CV. Savannah.

Basak, S. and Guha, P. (2018). A review on antifungal activity and mode of action of essential oils and their delivery as nanosized oil droplets in the food system. J. Food Sci. Technol., **55**(12):4701-4710.

Bayat, H.; Azizi, M.; Shoor, M. and Mardani, H. (2011). Effect of Ethanol and Essential Oils on Extending Vase-life of Carnation cut flower. Not Sci Biol., **3**(4):100-104.

Burt, S. (2004). Essential oils: their antibacterial properties and potential applications in foods, a review. Int. J. Food Microbiol., **94**:223-253.

El-Sayed, I.M. and El-Ziat, R.A. (2021). Utilization of environmentally friendly essential oils on enhancing the postharvest characteristics of Chrysanthemum morifolium Ramat cut flowers. Heliyon, **7**(1):1-10.

Fides Chrysanthemum Catalogues (2010). https://www.scribd. com/document/121227906/ Chrysanthemum- Cut-Catalogue.

Lambert, R. J. W.; Skandamis, P. N.; Coote, P. J. and Nychas, G. J. E. (2001). A study of the minimum inhibitory concentration and mode of action of organo-essential oil, thymol and carvacrol. Journal of Applied Microbiology, **91**:453-462.

Mihajilov-Krstev, T.; Radnovic, D.; Kitic, D.; Stojanovic-Radic, Z. and Zlatkovic B. (2010). Antimicrobial activity of Satureja hortensis L. essential oil against pathogenic microbial strains. Arch. Biol. Sci. Belgrade, **62**: 159-166.

Monika Bugos.; malgorzatawasidr. and Danuta kalember. (2012). Antimicrobial activity of geranium oil against clinical stains of staphylococcus aureus. moleculers, pp:10276-10291.

Silva, B.D.; Bernardes, P.C.; Pinheiro, P.F.; Fantuzzi, E. and Roberto, C.D. (2021). Chemical composition, extraction sources and action mechanisms of essential oils: Natural preservative and limitations of use in meat products. https://doi.org/10.1016/j.meatsci.2021.10 8463., Meat Sci., **176**:1-11.

Singh, A. K. and Tiwari, A. K. (2002). Effect of pulsing on post- harvest life of Rose cv. Doris Rystermann. South Indian Hort., **50:**140-144.

Solgi, M.; Kafi, M.; Taghavi, T. S. and Naderi, R. (2009). Essential oils and silver nano particles (SNP) as Novel agents to extend vase-life of Gerbera (*Gerbera jamesonii* cv. Dune) flowers. Post harvest Biology and Technology, **53**:155-158.

Shanan, N. T. (2012). Application of essential oils to prolong the display life of Rose (*Rosa hybrida* L. cv. Grand) cut flowers. Journal of Horticultural Science and Ornamental Plants, **4(1)**:66-74.

Citation **A. Nirmala, A. Manohar Rao, P. Prasanth, S. Narendar Reddy and D. Srinivasachary (2026). Effectiveness of essential oils in maintaining quality and display life of cut Chrysanthemum (*Dendranthema grandiflora*) cv. Arctic Queen. Ann. Phytomed., 15(1):763-772, http://dx.doi.org/10.54086/ap.2026.15.1.69.**