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Determining the Potential of Lavender as Cut Flower: Enhancing Vase Life with Different Vase Solutions

Lavantanın Kesme Çiçek Potansiyelinin Belirlenmesi: Farklı Vazo Çözeltileri ile Vazo Ömrünün Artırılması

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DETERMINING THE POTENTIAL OF LAVENDER AS CUT FLOWER: ENHANCING VASE LIFE WITH DIFFERENT VASE SOLUTIONS

ABSTRACT

Lavender, renowned for its pleasant aroma and beautiful spike structure, is a popular decorative plant often utilized in dried form for vase arrangements. However, its potential as a fresh cut flower has been relatively underexplored. This study aimed to assess the potential of lavender as a cut flower and investigate the impact of various vase solutions on its vase life. Two different lavender species remove (*Lavandula angustifolia, Lavandula hybrida*) were subjected to seven different vase solutions: control (water), two different doses of silver nitrate ($AgNO_3$), salicylic acid, sodium hypochlorite, lavender essential oil, and vinegar. The effects of these solutions on vase life and overall quality were evaluated. Results indicate that lavender holds significant potential as a cut flower when placed in appropriate vase solutions. Among the solutions tested, silver nitrate treatments exhibited the longest vase life in both species, extending vase life up to threefold compared to the control, while also limiting microbial activity within the vase and preserving flower color. This study underscores the importance of selecting suitable vase solutions to maximize the vase life and aesthetic appeal of lavender as a cut flower.

Keywords: Cut Flower, Lavender, Ornamental Plant, Silver Nitrate.

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LAVANTANIN KESME ÇİÇEK POTANSİYELİNİN BELİRLENMESİ: FARKLI VAZO ÇÖZELTİLERİ İLE VAZO ÖMRÜNÜN ARTIRILMASI

ÖZ

Lavanta, hoş kokusu ve güzel başak yapısı ile tanınan, sıklıkla kurutulmuş formuyla vazo düzenlemelerinde kullanılan popüler bir süs bitkisidir. Ancak, lavantanın taze kesme çiçek olarak potansiyeli de oldukça yüksektir. Bu çalışma, lavantanın kesme çiçek olarak kullanım potansiyelini değerlendirmeyi ve çeşitli vazo çözeltilerinin vazo ömrü üzerindeki etkisini araştırmayı amaçlamıştır. İki farklı lavanta türü (*Lavandula angustifolia, Lavandula hybrida*), kontrol (su), iki farklı doz gümüş nitrat ($AgNO_3$), salisilik asit, sodyum hipoklorit, lavanta uçucu yağı ve sirke içeren yedi farklı vazo solüsyonu içerisinde denemeye alınmıştır. Bu vazo solüsyonlarının vazo ömrü ve genel çiçek kalitesi üzerindeki etkileri değerlendirilmiştir. Sonuçlar, lavantanın uygun vazo solüsyonlarında kesme çiçek olarak önemli bir potansiyele sahip olduğunu göstermektedir. Vazo solüsyonları arasında, gümüş nitrat içerikli uygulamalar her iki türde de en uzun vazo ömrünü sağlamış, kontrol grubuna kıyasla vazo ömrünü üç katına kadar arttırmış ve aynı zamanda vazodaki mikrobiyal aktiviteyi sınırlayarak çiçek rengini korumuştur. Bu çalışma ile lavantanın kesme çiçek olarak vazo ömrü ve estetik çekiciliğini maksimize etmek için uygun olan vazo solüsyonları belirlenmiştir.

Anahtar Kelimeler: Kesme Çiçek, Lavanta, Süs Bitkisi, Gümüş Nitrat.

INTRODUCTION

Lavender, an important ornamental and aromatic plant belonging to the *Lamiaceae* family (Guenther, 1954), carries economic importance as both an essential oil and an attractive decorative plant in dry regions. Particularly, *Lavandula hybrida* and *Lavandula angustifolia* are noteworthy for their substantial quantities and high-quality essential oils (Urwin et al., 2009; Dalda-Sekerci et al., 2024; Şimşek et al., 2024). Moreover, owing to lavender's pleasant aroma, it is utilized as a fresh-cut flower. Although lavender's value in the cut flower industry hasn't fully materialized, there's been a growing demand for it in recent years. Lavender varieties with elongated stems are prized as cut flowers, with their spikes being especially suitable for this purpose. Both fresh and dried spikes are preferred for decorative vase arrangements.

In Türkiye and worldwide, the production of cut flowers is predominant in trade due to their ease of cultivation and transportation (Gursan, 2002; Kelley et al., 2006; Schimmenti et al., 2013; Akca, 2019). Maintaining the freshness of the product from harvest onwards and ensuring a long vase life is crucial for a quality cut flower trade (Batt, 2001; Akca et al., 2019). Therefore, studies on practices starting from the harvest of cut flowers and extending their vase life are highly significant. Various factors influence the vase life of cut flowers, including the plant's genetic structure, pre-harvest conditions (cultivation practices and cultural treatments), harvest timing, and post-harvest treatments. The vase life of cut flowers tends to shorten due to various factors, primarily due to the blockage of microbial vessels, interrupting water uptake and transport, and depletion of respiratory substrates limiting energy for sustaining life processes (Kazaz et al., 2008; Elgimabi and Ahmed, 2009; Danaee et al., 2011; Fanourakis et al., 2013). In addition, there is also the accelerating effect of ethylene on aging in ethylene-sensitive species and the harmful effects of reactive oxygen species (ROS) that occur during oxidative stress after the separation of flower stems from the parent plants (Skutnik et al., 2021). It has been noted that interventions at the antioxidant level through different applications in vase solutions extend vase life. Asrar (2012), emphasized the necessity of two fundamental substances, sugar and antiseptic agents, in vase solutions. While added sugar provides respiratory substrates, antiseptic agents are essential for preventing bacterial growth, proliferation, and blockage of vascular bundles. Sucrose is the most commonly used sugar to extend the vase life of cut flowers (Pun et al., 2003; Lama et al., 2013; Norikoshi et al., 2016).

Effective in limiting the microbial population in vase water, 8-hydroxyquinoline citrate (Islam et al., 2003; Bahrami et al., 2013; Sharifzadeh et al., 2014), aluminum sulfate (Liao et al., 2001), sodium hypochlorite (Lakshmaiah et al., 2019), silver nitrate (Hutchinson et al., 2013), nano-silver (Lü et al., 2010), silicon and silver (Kiamohammadi, 2012), have been reported to extend vase life, especially when applied together with sucrose. Sodium hypochlorite can reduce bacterial counts in the vase and extend the flowers vase life (Halevy and Mayak, 1981; Macnish et al., 2010). However, effective concentrations can be toxic to flowers (Knee, 2000; Macnish et al., 2010). $AgNO_3$ can act either as an antimicrobial agent (Mayak et al., 1977; van Doorn, 2010), or as an inhibitor of ethylene synthesis and ethylene action. Salicylic acid has been found to delay the senescence of gladiolus flowers (Alaey et al., 2011). The salicylic acid has effects such as inhibiting ethylene biosynthesis and seed germination, blocking wound responses, reducing transpiration in leaves and epidermis, and reversing ABA-induced stomatal closure (Özeker, 2005).

In this study, the effects of solutions prepared using chemical agents such as silver nitrate ($AgNO_3$), sodium hypochlorite, and salicylic acid, as well as natural solutions with added vinegar, lavender essential oil, and sugar, on the vase life of lavender cut flowers were investigated. This study aims are to explore the potential use of lavender, commonly used as a garden plant or dried flower, as a cut flower and to determine the vase life durations within different vase solutions.

MATERIAL AND METHODS

Plant Materials

The research was carried out at the Department of Horticulture, Erciyes University. Cut lavender spikes from two distinct species, *Lavandula angustifolia* and *Lavandula hybrida*, were assessed in the study. The spikes were harvested when approximately 80% of the flowers on each spike had bloomed, ensuring that they had stems of appropriate length for vase placement.

The Vase Solutions Used in the Study

Flowers were harvested at a commercial stage where approximately 80% of flower clusters exhibited the colors characteristic of the variety (Kitamura et al., 2017). Within half an hour after harvest, they were transported to the laboratory in a dry condition. Stems were re-cut to minimize contamination in a vase life chamber. Subsequently, they were placed in glass bottles (1000 ml), containing 750 ml of different vase solutions.

The experiment was set up in triplicates for each of the two lavender species, with 50 g of lavender placed in each vase. A total of 6 different vase solutions and a control were prepared (Table 1). The experiment was conducted under conditions of 22-24°C room temperature and 30% humidity. The aim was to carry out the experiment under conditions resembling a household environment.

Table 1. Contents of vase solutions for cut lavender

Treatments	Species	Vase Solutions
T1-A	*Lavandula angustifolia*	50 mg/L $AgNO_3$
T2-A	*Lavandula angustifolia*	100 mg/L $AgNO_3$
T3-A	Lavandula angustifolia	Vinegar (6%) + sucrose (6%)
T4-A	*Lavandula angustifolia*	Sodium hypochlorite (3mg/L)
T5-A	*Lavandula angustifolia*	Salicylic acid (5mg/L)
T6-A	*Lavandula angustifolia*	Control- tap water
T7-A	*Lavandula angustifolia*	Lavender essential oil (5mg/L)
T1-H	*Lavandula hybrida*	50 mg/L $AgNO_3$
T2-H	*Lavandula hybrida*	100 mg/L $AgNO_3$
T3-H	*Lavandula hybrida*	Vinegar (6%) + sucrose (6%)
T4-H	*Lavandula hybrida*	Sodium hypochlorite (3mg/L)
T5-H	*Lavandula hybrida*	Salicylic acid (5mg/L)
T6-H	*Lavandula hybrida*	Control- tap water
T7-H	*Lavandula hybrida*	Lavender essential oil (5mg/L)

The assessed characteristics encompassed vase life, relative fresh weight, and solution uptake. Vase life was documented on a daily basis, with conclusion reached upon the observation of wilting, browning of sepals, or drying of sepals in roughly 80% of the flowers (Kitamura et al., 2017). Weights of vases were measured both with and without flowers, and evaluations of fresh weight and solution uptake were conducted every other day.

Relative fresh weight (%); Relative fresh weight, expressed as a percentage, was determined by measuring the change in fresh weight using the formula: Relative Fresh Weight (%) = (Wt/Wt-0) x 100, where Wt represents the weight of the stem (in grams) at t = 0, 1, 2 days, and so forth, and Wt-0 denotes the weight of the same stem (in grams) at t = 0 day (He et al., 2006).

Solution uptake; Solution uptake was assessed on a daily basis and quantified in terms of both daily and cumulative solution uptake. The formula for daily solution uptake is: Daily Solution Uptake (g stem−1 day−1) = (St−1 – St), where St represents the weight (in grams), of the vase solution on days 1, 2, 3, and so forth, and St−1 denotes the weight of the vase solution on the preceding day (He et al., 2006; Lü et al., 2010).

The Bacterial Quantity in Vase Solution; The amount of bacteria in the vase solution was determined by scoring the solutions obtained after the end of the vase life of lavender plants on a scale of 1-5. Additionally, the Flower Shedding Density in lavender spikes was observed and recorded.

Spike Color Measurements; Spike color measurements were conducted using a Konica Minolta colorimeter device (Chroma Meter, CR-400). The average values of the readings for L (lightness/darkness), a* (red/green), and b* (yellow/blue) were calculated to obtain results (Trigueros et al., 2011; Ucok, 2019). Spike colors were measured in terms of L, a*, and b*, and utilizing the a* and b* values, Chroma (C) and Hue angle (h°) were calculated. The calculated Hue angle represents: 0=red, 90=yellow, 180=green, and 270=blue (Siomas et al., 2002; Madeira et al., 2003; Ucok, 2019).

Formula; $C^*: \sqrt{(a^2+b^2)}$ and $h^o: \tan^{-1}(b/a)$

The study comprised seven treatments and was carried out using a completely randomized design (CRD) with three replicates, each replicate consisting of three flowers. The data obtained from the study were analyzed using the "JMP 13.2.0" software according to the factorial experimental design in randomized complete blocks. The treatment means were compared using Tukey's Honestly Significant Difference (HSD) test (Snedecor and Cochran, 1967). Also, PCA and correlation analyses were carried out JMP 13.2.0 software.

RESULTS AND DISCUSSION

Vase Life

The vase life is terminated when the rate of wilting in the flower spikes or the rate of leaf drying reaches 80% (Namita et al., 2006; Kitamura et al., 2017). In this study, seven different vase solutions were used to evaluate the vase life of cut lavender flowers. According to the obtained results, all applications except for lavender essential oil had a longer vase life compared to the control group. The longest vase life in *Lavandula angustifolia* was achieved with the T2 (100 mg/L $AgNO_3$) treatment, with 11.33 days. This was followed by the T1 (50 mg/L $AgNO_3$) treatment with 10.67 days. The vinegar (6%) + sucrose (4%) vase solution, salicylic acid vase solution, and sodium hypochlorite-containing vase solutions also had a longer vase life compared to the control. The vase life in silver nitrate-containing vase solutions increased up to threefold compared to the control (Table 2 and Figure 1).

In *Lavandula hybrida* species, the longest vase life was obtained with the T1 (50 mg/L $AgNO_3$) treatment, lasting 8.33 days. The T2 treatment (100 mg/L $AgNO_3$) followed with a vase life of 7.33 days. The T3, T4 and T5 vase solutions also had a longer vase life compared to the control. The findings indicate that *L. angustifolia* species have a longer vase life compared to *L. hybrida* species, and vase solutions treated with lavender oil had the lowest vase life. In *L. hybrida* species as well, silver nitrate-containing vase solution applications increased vase life up to two times compared to the control (Table 2 and Figure 1).

The results obtained in this study are consistent with previous research. Silver nitrate ($AgNO_3$) is a potent inhibitor of ethylene action in plant tissues. A study reported that $AgNO_3$ application reduced ethylene production in cut rose flowers compared to the control (Ketsa, 1995). Norikoshi et al. (2016), indicated that sucrose application increased the concentrations of glucose and fructose within the vacuole, thereby enhancing water uptake and supporting cell expansion during flower opening. However, it has also been reported that carbohydrates, especially sucrose, may lead to an increase in bacterial populations in vase water, potentially causing blockages in the cut flower xylem vessels (Hajizadeh et al., 2012). In line with these views, nanoparticles have been observed to contribute to a longer vase life by reducing antimicrobial activity. In similar studies, various chemical substances known for their antimicrobial effects, such as silver thiosulfate (STS), silver nitrate ($AgNO_3$), hydroxyquinoline sulfate (8-HQS), and hydroxyquinoline citrate (8-HQC), have been used and found to be highly effective in extending the vase life of gerbera flowers (Khan et al., 2015; Mohamed et al., 2018; Sharma et al., 2018). Previous studies have reported that the addition of silver nitrate to vase water prevents the occlusion of vascular bundles and effectively prolongs vase life (Nowak and Rudnicki, 1990; Damunupola and Joyce, 2008). In another study, it was noted that the highest vase life in cut rose flowers was achieved when the flowers were placed in preservative solutions, and sodium hypochlorite-containing vase solutions were reported to inhibit bacterial formation, thus extending vase life (Masoome et al., 2003).

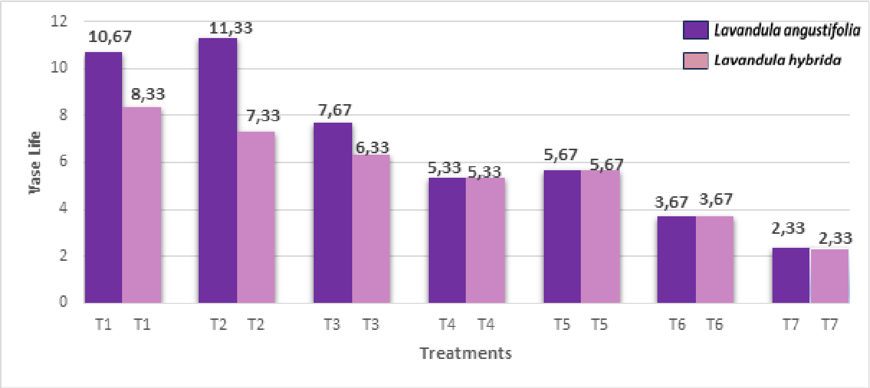

Figure 1. Graph showing the effects of different vase solutions on the vase life of cut lavender

Table 2. Vase life periods of cut lavender depending on different vase solution

Treatments	Vase Life
T1-A	10,67 a
T2-A	11,33 a
T3-A	7,67 bc
T4-A	5,33 ef
T5-A	5,67 de
T6-A	3,67 fg
T7-A	2,33 g
T1-H	8,33 b
T2-H	7,33 bcd
T3-H	6,33 cde
T4-H	5,33 ef
T5-H	5,67 de
T6-H	3,67 fg
T7-H	2,33 g
Species x Treatment	**
* p<0.05, **p<0.01	

Relative Fresh Weight Value (%) Results

It was found that different vase solution applications caused statistically significant differences in proportional fresh weight among all plants, and applications made on the 2nd, 4th, 6th, 8th, 10th and 12th days were statistically significant in lavender species. In *Lavandula angustifolia* species, on the second day, proportional fresh weights varied between 86.39% and 97.72% among treatments. On the final day, flowers with the highest proportional fresh weight were observed in the 50 mg/L $AgNO_3$ (T1) treatment, with 79.72%. The lowest values were observed in the control, salicylic acid-containing vase solution (T5), and sodium hypochlorite-containing vase solution (T4) treatments, with 46.78%, 47.78%, and 47.89%, respectively. A positive correlation between vase life and proportional fresh weights has been determined (Figure 2). Also, the interactions between species and different vase solution treatments were found to be statistically significant.

In *Lavandula hybrida* species, on the second day, proportional fresh weights varied between 110.89% and 72.44% among treatments. On the final day, the treatment with the highest proportional fresh weight was the 100 mg/L $AgNO_3$ (T1) treatment, with 91.17%. The lowest values were observed in lavender essential oil-containing vase solutions (T7) and salicylic acid-containing vase solutions (T5), with 46.72% and 47.11%, respectively. Proportional fresh weight showed a gradual decrease after a certain period. A positive correlation between vase life and proportional fresh weights was observed (Figure 2). In terms of relative fresh weights, interactions between species and different vase solution treatments were also found to be statistically significant.

Previous studies have also observed increases in proportional fresh weights in vase treatments, with increases continuing up to 7 to 8 days and then declining (Alaey et al., 2011; Unsal, 2022). In vase life, a high number of isolated bacteria in vase solution led to a sharp decrease in flower fresh weight (Li et al., 2012). In Movie Star cut roses, stem fresh weight rapidly increased in the first 40 hours of the vase period and then gradually decreased (Lü et al., 2011). Vascular blockage caused by bacteria leads to reduced water uptake and ultimately results in stem bending, breaking, and leaf wilting in roses (Nair et al., 2003; Balestra et al., 2005; Meman and Dabhi, 2006; Solgi et al., 2009). In the study by Soleımany-Fard et al. (2013), salicylic acid treatment on alstroemeria flowers resulted in a significant increase in proportional fresh weight during the first 4 days of the experiment, followed by a significant decrease until the end of the experiment. Similar patterns of change have been reported for cut rose flowers, where a decrease in proportional fresh weight over days after harvest may be attributed to a reduction in water uptake (Lü et al., 2010; Alaey et al., 2011; Soleımany-Fard et al., 2013).

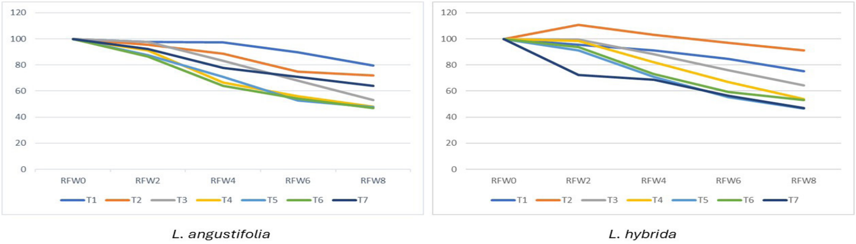

Figure 2. Graph showing changes in relative fresh weight of cut lavender during vase life

Daily Solution Uptake Results

In the first measurement regarding daily vase solution uptake in *Lavandula angustifolia* species, the highest solution uptake was observed with 80 g in the vase solution containing salicylic acid application. The lowest solution uptake was obtained as 26.17 g in the treatment of 50 mg/L $AgNO_3$ (T1). On the last day of vase life, the highest daily solution uptake values are, respectively, in treatments T1, T2, T6, T5, T7, and T4. The lowest value occurred in the T3 treatment. Daily solution uptake in *Lavandula hybrida* species decreased gradually. At the end of vase life, the highest values are in treatments T1, T3, T2, T7, T4, T5, respectively. The lowest value was detected in the T6 application (Figure 3). While daily solution uptake may be insignificant, statistical significance has been found in the interactions between total solution uptake, species, and different vase solution treatments.

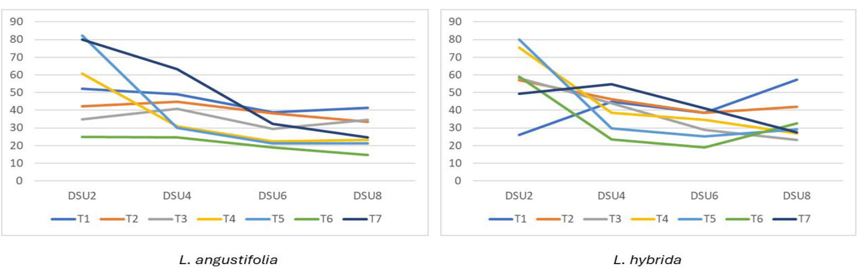

Figure 3. Graph showing changes on the daily solution uptake of cut lavender during vase life

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Results of Color Measurement in Cut Lavender Flowers

The color characteristics of lavender spikes were measured using a Minoltachromameter, determining chroma values and hue angles. Upon examining the color properties of cut lavender flowers, it was observed that flower colors were preserved compared to the control in various vase solution applications. In *L. angustifolia* species, lavender cut flowers appeared brighter and more purple in the applications of 50 mg/L $AgNO_3$ and 100 mg/L $AgNO_3$. Similarly, in *L. hybrida* species, the treatment of 100 mg/L $AgNO_3$ resulted in the highest quality flower color. Additionally, in both species, T3 vase solutions reduced color loss in flowers compared to the control (Table 3).

Table 3. Changes on the flower color of cut lavender over vase life

UYGULAMA	L	a*	b*	CHROMA	HUE
T1-A	42,14 ab	7,53 a-d	-6,99 abc	18,15	26,69 a
T2-A	39,53 ab	9,52 ab	-7,51 abc	17,35	8,61 a
T3-A	35,15 ab	2,87 bcd	-0,27 ab	13,8	8,56 a
T4-A	30,49 b	3,01 bcd	-0,79 ab	12,27	-1,93 a
T5-A	36,17 ab	3,17 bcd	-0,88 ab	10,3	-2,75 a
T6-A	34,05 ab	3,64 bcd	-1,12 ab	5,18	-5,63 a
T7-A	33,62 ab	4,14 bcd	-2,08 abc	4,16	-8,2 a
T1-H	38,63 ab	12,64 a	-13,02 c	4,12	-20,98 a
T2-H	41,93 ab	12,16 a	-12,33 c	4,06	-22,19 a
T3-H	44,08 a	9 abc	-10,45 bc	3,81	-35,93 a
T4-H	31,39 ab	1,89 cd	0,19 ab	3,78	-41,23 a
T5-H	33,6 ab	2,19 cd	-0,15 ab	3,15	-44,01 a
T6-H	31,56 ab	1,9 cd	1 a	2,62	-45,73 a
T7-H	40,4 ab	0,96 d	2,42 a	2,36	-48,11 a
Species x Treatment	*nsg*	*	*	*nsg*	**

* $p<0.05$, **$p<0.1$

The Observation of Bacterial Content in Vase Solution and Senescence Rate in Cut Lavender Flowers

The contamination of vase solutions has been observed during period. After the expiration of the vase life, the amount of bacterial accumulation in the vase water was determined by scoring on a scale of 1-5. The highest bacterial accumulation was detected in the vase water of *L. angustifolia* species in the T7 application. This was followed by vase solutions from T4, T6, and T5 applications, respectively. The lowest bacterial density was obtained from the T1 application, followed by the T2 treatment. In *L. hybrida* species, the highest value was obtained from the lavender oil (T7), as in *L. angustifolia*, with the same value (Figure 4). This was followed by T4, T6, and T5, respectively. The lowest value was obtained from the T1 treatment, followed by the T2-T3 treatments. The T3-vinegar+sucrose solution, while sugar is nutritive, vinegar reduces antimicrobial activity, resulting in a lower bacterial count compared to the other three treatments (T4-sodium hypochlorite, T5-salicylic acid, T6-sodium hypochlorite). Previous studies have reported the high antimicrobial effect of lavender oil (Badr et al., 2021; Yılmaz and Karadag 2021). However, it is thought that the components within lavender oil, which have antimicrobial properties, do not show their effects due to being oils of the same species in cut lavender flowers. In lavender cut flowers, flower senescence can also occur in lavender spikes. The most flower senescence in spikes of *L. angustifolia* occurred in treatment T7. This was followed by vase solution applications of T4, T5, and T6, respectively. The lowest flower senescence in spikes was obtained from the T1, T2, and T3 treatments. In *L. hybrida* species, the most shedding in flowers occurred in the T7 treatment. This was followed by T4, T6, T2, T1, and T5 treatments. The least senescence occurred in the T3 treatment.

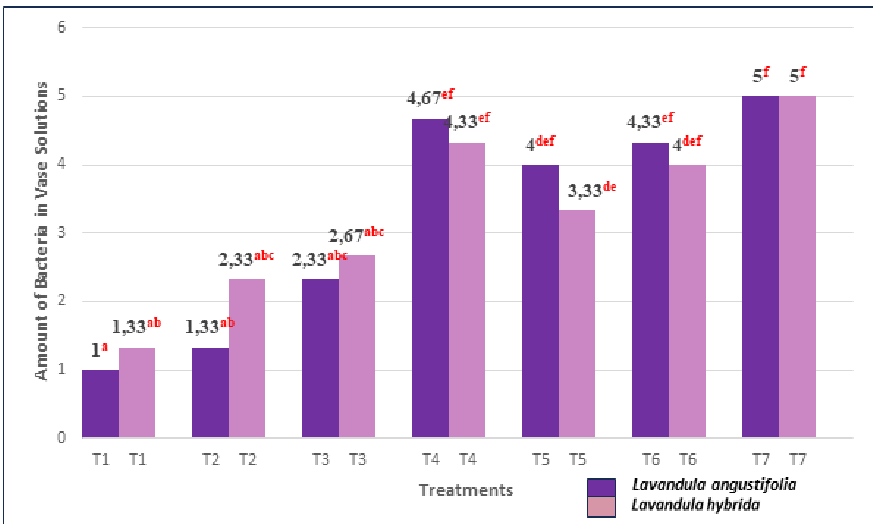


Figure 4. Graph showing the amount of bacteria in different vase solutions

Results of Principal Component Analysis (PCA) and Correlation Analysis

In this study, the effects of seven different vase solutions on vase life, flower color, and the accumulation of bacterial quantities in the vase solution were supported by PCA analyses. According to the obtained PCA analysis, the graphical representations explain 83% of the variance (Component1: 67.3%; Component2: 15.9%). Upon examination of the findings, a linear relationship between vase solutions extending vase life and flower color parameters is observed. Additionally, it is noted that the accumulation of bacteria in the vase is inversely related to vase life parameters. As bacterial formation in the vase solution increases, vase life decreases (Figure 5). Furthermore, based on the scatterplot matrix and correlation analysis created between different vase solutions and vase life parameters, correlation coefficients between vase solutions, vase life, flower color, and vase bacterial formation have been determined (Figure 6).

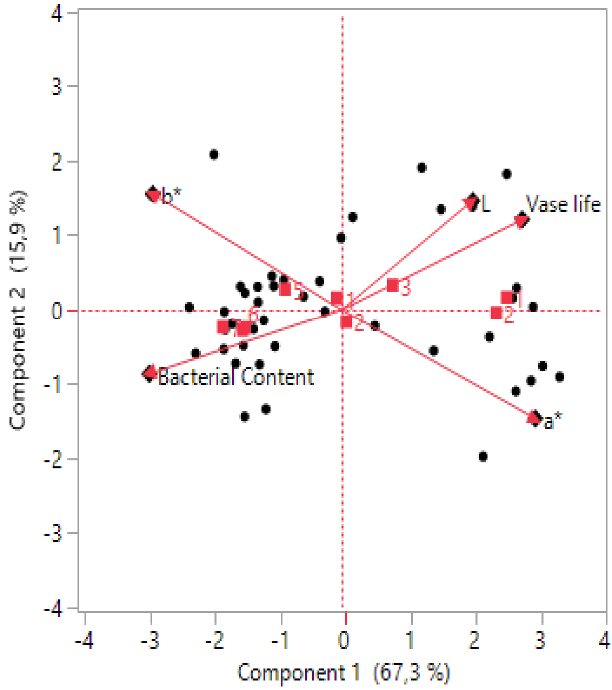
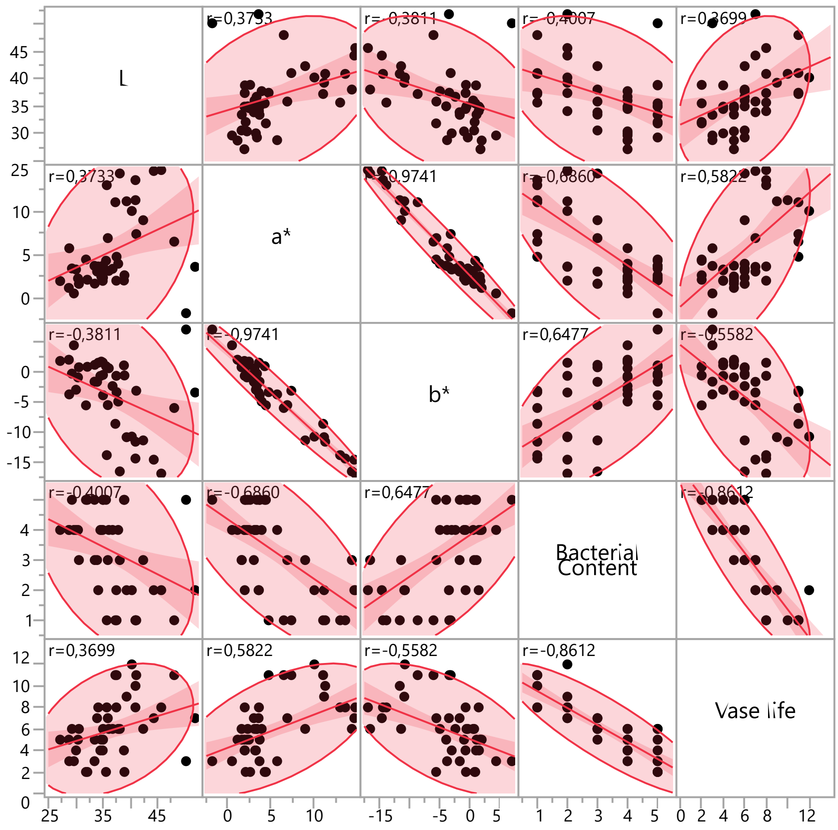


Figure 5. Principal Component Analysis (PCA) between different vase solutions with vase life, flower color and the amount of bacteria accumulated in the vase



	L	a*	b*	Bacterial Content	Vase life
L	1,0000	0,3733	-0,3811	-0,4007	0,3699
a*	0,3733	1,0000	-0,9741	-0,6860	0,5822
b*	-0,3811	-0,9741	1,0000	0,6477	-0,5582
Bacterial Content	-0,4007	-0,6860	0,6477	1,0000	-0,8612
Vase life	0,3699	0,5822	-0,5582	-0,8612	1,0000

Figure 6. Scatterplot matrix and correlation of the vase life parameters of lavender with different vase solutions treatments.

CONCLUSION

This study has determined that lavender can be used as cut flowers in vases. It was found that under the correct vase solution, lavender can have a vase life of over 10 days. In both lavender species, vase solutions with the addition of $AgNO_3$ resulted in longer vase life. The $AgNO_3$ treatments used in the study increased the vase life compared to other treatments. According to this study, the longest vase life in both species was observed in silver nitrate, vinegar sugar, sodium hypochlorite, and salicylic acid solutions, respectively. However, the vase life was found to be lower in the control and lavender essential oil solutions.

The results of proportional fresh weight indicated that silver nitrate, vinegar sugar, and lavender oil solutions provided high values on the final day in *L. angustifolia* species, while silver nitrate and vinegar sugar solutions provided high values in *L. hybrida* species. Sodium hypochlorite, salicylic acid, control, and lavender oil solutions resulted in low proportional fresh weights. In *L. angustifolia* species, low fresh weights were determined in sodium hypochlorite, salicylic acid, and control treatments.

This study is consistent with previous studies. Additionally, it has supported the positive effects of sugar in extending vase life, including factors such as maintaining stem quality, sustaining turgor, providing nutrients, and regulating water balance and osmotic pressure. The addition of salicylic acid and sodium hypochlorite to the vase has been shown to increase vase life by limiting antimicrobial activity. Silver nitrate is a potent inhibitor of ethylene effects in plant tissues. The $AgNO_3$ treatment not only extended vase life compared to the control, but also contributed to reducing microbial activity within the vase solution and reducing flower shedding in spikes while preserving flower color. This study identifies lavender as an alternative cut flower for vases while also determining vase solutions that increase vase life.

Conflict of Interest

The author declares that there is no conflict of interest.

Ethics

This study does not require ethics committee approval.

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