Turkish Journal of Food and Agriculture Sciences

5(1): 19-25 (2023)

TURJFAS

Research Article

DOI: https://doi.org/10.53663/turjfas.1266719

EFFECT OF PLANT GROWTH PROMOTING RHIZOBACTERIA ON THE VASE LIFE OF GERBERA FLOWERS

Güzella YILMAZ[1*], Betül TARHANACI[2], Sabriye BELGÜZAR[2], Zeliha KAYAASLAN[3], Kenan YILDIZ[1]

[1] Tokat Gaziosmanpaşa University, Faculty of Agriculture, Department of Horticulture, Tokat, Türkiye
[2] Tokat Gaziosmanpaşa University, Faculty of Agriculture, Department of Plant Protection, Tokat, Türkiye
[3] Yozgat Bozok University, Faculty of Agriculture, Department of Plant Protection, Yozgat, Türkiye

ARTICLE INFO

HISTORY

Received: 17 March 2023
Revised: 3 April 2023
Accepted: 5 April 2023
Online Published: 30 June 2023

KEYWORDS

Gerbera
Vase life
Plant growth promoting rhizobacteria
Cut flowers
Ornamental flowers

A B S T R A C T

In this study, the effects of three different bacterial isolates added to the vase solution on the vase life were investigated. All three bacterial isolates significantly increased the vase life of gerbera cut flowers. While the vase life of the flowers in the control solution was 3 days, this period reached up to 11 days in the flowers kept in the vase containing bacteria. Daily water uptake decreased with increasing time in vase in all treatments. Although there were some differences between treatments in terms of daily water uptake, it has been determined that bacteria application does not have a significant effect on water uptake. The relative fresh weight decreased with increasing time in the vase. For example, in the solution containing Z7 bacteria, which allows the flowers to live the longest, the flower weight, which was 89 g on August 11, decreased day by day and decreased to 68 g on August 23. Bacteria applications slowed the rate of decrease in fresh weight. *Bacillus cereus* found to be more effective than other bacterial isolates in slowing fresh weight decrease.

* CONTACT

guzella.yilmaz@gop.edu.tr

Citation: Yılmaz, G., Tarhanacı, B., Belgüzar, S., Kayaaslan, Z., & Yıldız, K. (2023). Effect of plant growth promoting rhizobacteria on the vase life of gerbera flowers. *Turkish Journal of Food and Agriculture Sciences*, *5*(1), 19-25

ORCİD>0000-0002-9284-9698 (GY), ORCİD >0000-0002-3694-0104 (BT), ORCİD >0000-0002-8892-0017 (SB), ORCİD >0000-0001-7063-0073 (ZK), ORCİD >0000-0003-3455-5146 (KY)

1. Introduction

Cut flower, a group of ornamental plants with high added value, gained importance in the early 20th century and become a growing industry in many parts of the world. The cut flowers production area is increasing in Türkiye as well as in other countries of the world. In Türkiye, 1237.4 ha of the 5247.7 ha ornamental plants production area has been reserved for cut flowers production. In addition, 36 million dollars of the 80 million dollars revenue earned from the total ornamental plant exports in 2019 was obtained from the cut flowers. Cut flower production has the largest share (60.9%) in total ornamental plant production (Anonymous, 2020).

Gerbera sp., which belongs to the Asteraceae family, is used as a pot or cut flower (Minerva and Kumar, 2013), and is the most sold flower species in the Royal Flora flower auction of Netherlands, following important species such as rose, tulip, chrysanthemum and lily (Anonymous, 2017). The area reserved for Gerbera production in Türkiye is in the third following carnations and roses, while the amount of gerbera production is in the second place after cloves (TUIK, 2018).

The vase life of flowers is an important factor determining the commercial value of a flower (Kılıç and Yaman, 2020), and the long vase life increases the value of cut flowers in the domestic and foreign market. Therefore, storage and transportation methods should be improved to extend the durability of flowers. Enabling long-term durability will make a significant contribution to the economy in the cut flower sector. Genetic characteristics of the plant species, cultural processes, environmental conditions, flower cutting place, harvest time, water quality in the vase, microorganism activity in the water and the amount of toxic substances and post-harvest processes are effective on the vase life (Uzun et al., 1983).

The most important factor determining the vase life is the microorganism activities in the vase solution. Previous studies revealed that these microorganisms reduce the water intake by clogging the vascular bundles directly or with the substances they secrete (Elhindi, 2012; Lie et al., 2017), thus the water balance of the plants is wilted, and the vase life is shortened (Tuna, 2012). The treatments to reduce the formation of microorganisms in the vase solution are effective in prolonging the vase life of cut flowers (Safa et al., 2015; Khan et al., 2015; El-Sayed, 2018; Sharma et al., 2018). Some researchers have pointed out that the effect of bacteria on vase life varies depending on the type of bacteria (Van Doorn et al., 1991; Jacob and Kim, 2010; Carlson et al., 2015). Contrasting findings have been reported about the effects of microorganisms on vase life of cut flowers. Some researchers reported that bacteria in the vase solution have little or no effect on the vase life (Van Doorn et al., 1991;1995), while some revealed that the vase life can be extended by adding bacteria to the vase solution (Carlson et al., 2015; Naing et al., 2017).

Naing et al. (2017) claimed that bacteria with biocontrol agent properties can contribute to extend life of cut flowers by killing harmful bacteria formed in the vase solution. In this study, the effects of solutions containing *Bacillus cereus*, *Pseudomonas putida* and *Acinetobacter calcoaceticus* isolates, which can promote plant growth directly or by suppressing different disease factors (Imriz et al., 2014), on vase life of gerbera flowers were investigated.

2. Materials and methods

2.1. Plant materials

Gerbera flowers of Opera cultivar were used in the study. The stems of the harvested flowers were transported to the laboratory in a bucket full of water, cut at 45 cm lengths and placed in vases containing 250 ml of solution. In this study, the effects of 8 different vase solutions [distilled water as control, 4% vinegar (V), 108 cells/ml *Bacillus cereus* (Z7), 108 cells/ml *Bacillus cereus* + 4% vinegar (Z7+V), 108 cells/ml *Pseudomonas putida* (Z12), 108 cells/ml *Pseudomonas putida* + 4% vinegar (Z12+V), 108 cells/ml *Acinetobacter calcoaceticus* (Z13), 108 cells/*ml Acinetobacter calcoaceticus* + 4% vinegar (Z13+V)] on vase life of cut flowers were investigated. Sucrose (4%) was added to all solutions including the control. The bacterial isolates used were collected from different parts of healthy pepper plants in the pepper production areas of Tokat province. The isolated were identified by morphological, physiological, biochemical tests and MALDI- TOF

MS technique. The isolates, which were kept as stock cultures in the refrigerator, were grown on Nutrient Agar medium for 24 h at 27 °C. Bacterial suspension was prepared with sterile distilled water using the growing bacterial isolates. The density of suspensions was adjusted to 0.3 absorbance value (108 cells/ml density) under 600 nm light in a spectrophotometer. The study was set up in a randomized plot design with 3 replications and 3 plants in each replication. Cut flowers placed in the vases were stored at room temperature (25-26 °C).

2.2. Methods

The observations were carried out daily during the storage period, and the vase life, solution uptake of cut flower stalks and fresh weight ratio were recorded daily. The vase life refers the number of days from placement of flowers in a vase to the time that the flowers are wilting or the stem is bent more than 90º. The end of vase life for a treatment was considered when 2 out of 3 flowers in a repetition wilted or bend more than 90º. Water uptake (WU) was calculated using the amount of fresh water that per gram cut flower absorbs in two days.

SA =St-2 – St / A0

In the equation, St-2 is the amount of solution at two days ago (ml), St is the amount of solution on t day (ml), and Ao is the flower weight (g) measured at the beginning. Fresh weight ratio (FWR) was calculated using the following equation;

FWR= At/A0 x 100

In the equation; At is the weight of a cut flower on t day; A0 is the initial weight of a flower.

The water uptake data, which had normal distribution and the variances were homogeneous, were subjected to variance analysis, and the mean values of the treatments were compared with the Duncan multiple comparison test. In contrast, the FWR values had non-normal distribution, therefore the FWR data converted to normal distribution by square root arsine transformation prior to the statistical analysis. Vase life values measured as the number of days were analyzed with the Kruskal-Wallis test, which is one of the nonparametric tests, and the mean values of the treatments were compared with the Bonferroni multiple comparison test.

3. Results

All three bacterial isolates added to the vase solution caused a significant increase in the vase life of gerbera cut flowers compared to the control. The vase life of cut flowers kept in the control solution was 3 days, while the vase life of the flowers in solutions containing Z7, Z12 and Z13 bacterial isolates were 11.3, 9.9 and 8.7 days, respectively (Figure 1). It has been determined that vinegar added to the vase solution causes an increase in the vase life of the flowers, although not as much as the bacteria application. The effects of bacteria in the solutions without vinegar were not seen in the solutions with vinegar. The effect of all three bacterial isolates tended to decrease in the vinegar medium compared to the vinegar-free medium. The flowers in the solution containing only Z7 bacteria had a vase life of 11.3 days, while the vase life of the same bacteria was only 6 days when applied with vinegar (Figure 1). A similar vase life was recorded in the other two bacterial applications with and without vinegar.

The water uptake of cut flowers was measured at two-day intervals. In all treatments, the highest water uptake occurred in the first two days. In the first two days of water uptake, Z7+V treatment received more water compared to Z7, Z12 and Z13 treatments. The differences in water uptake between other treatments in the first two days were not significant. The differences between other treatments, except for the between vinegar added (V) and control treatments were not significant on the 3rd and 4th days of the vase. The amount of water uptake between the treatments on the 5th and 6th days was slightly different, while the water uptake level in the later periods was similar in all treatments (Figure 2).

Total amount of water uptake in the Z7, Z12 and Z13 treatments during the waiting period in the vase was higher compared to the other treatments. The lowest total water uptake was recorded in the control.

The relative fresh weights in all treatments slightly decreased until the 4th day of vase life. The decrease in fresh weight of Z7+V and Z12+V treatments increased after the 4th day. The relative fresh weight of flowers in the Z7+V and Z12+VS treatments on the 6th day, which was the end of the vase life, decreased to 70 and 79.1%, respectively. The decrease in the relative fresh weight of Z13 and Z12 treatments increased after the 6th day. The relative fresh weight of cut flowers in Z13 treatment decreased to 69.9% at 8th day of the vase life. The flowers in Z12 maintained 55.9% of their initial weight at the 10th day of the vase life (Figure 3).

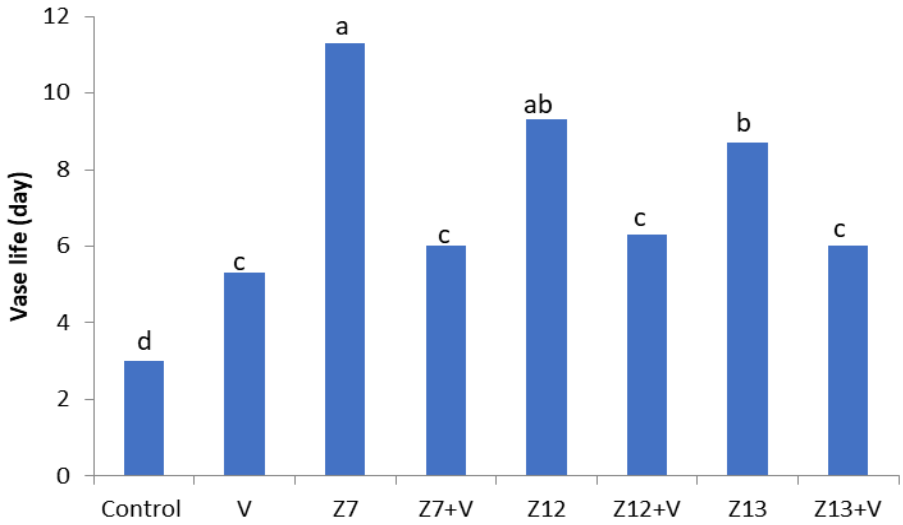

Figure 1. Effect of PGPRs on vase life in gerbera flower

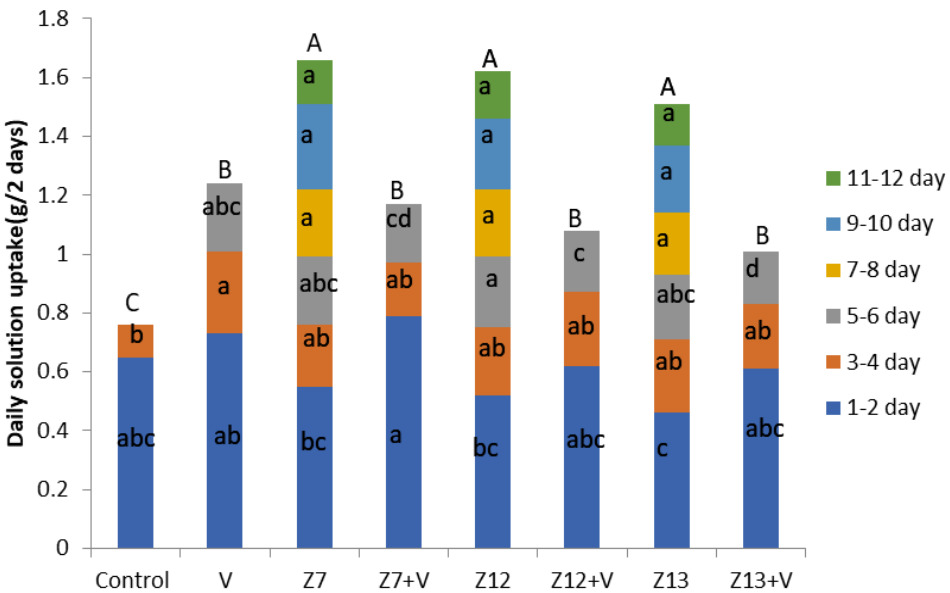

Figure 2. Two-day solution uptake of flowers kept in different solutions.

The difference between means of two-day water uptake, denoted by the same lowercase letter, is not significant. The difference between the means of total water uptake indicated with the same capital letter is not significant.

4. Discussion

Quality loss in cut flowers has mostly been associated with clogging of the xylem vessels by microorganisms accumulating in the vase solution (Knee, 2000). The findings indicating that vase life can be increased with applications that will prevent the accumulation of microorganisms in the vase solution are in line find the aforementioned cause of quality loss in cut flowers (Mengüç et al., 1991). The increase in vase life with the vinegar application can be attributed to the bactericidal effect of vinegar (Fei et al., 2010) that reduced the amount of bacteria in the vase solution. Some studies reported that the bacteria accumulated in the vase solution shortens the vase life (Solgi et al., 2009; Hassan et al., 2014; Lie et al., 2017), while others revealed that some bacteria may increase the vase life of cut flowers (Carlson et al. 2015; Naing et al., 2017). In addition, Jacob and Kim (2010) indicated that the effect of microorganisms varies depending on the type of bacteria present in the solution. Similarly, all three bacteria used in the experiment extended the vase life of gerbera cut flowers. Naing et al. (2017) revealed that the E. cloacae bacteria applied to the vase solution increased the water uptake and vase life of cut flowers, and the researchers associated the results with the destructive effects of E. cloacae bacteria on the microorganisms in the vase solution. In this study, Total water uptake was higher in bacterial applications, however, a significant increase in daily water uptake due to bacterial applications was not detected. The result indicates that the increase in vase life caused by bacteria cannot be explained by the increase in water uptake alone. Naing et al. (2017) stated that the positive effect of E. cloacae bacteria on vase life of cut flowers may be related to the inhibition of ethylene synthesis, and/or increased antioxidant activity by the bacteria. Therefore, the positive effect on vase life recorded in this study may be related to the change in ethylene synthesis and antioxidant activity.

Co-application of the bacteria with vinegar decreased the efficiency of the bacteria. This may be due to acidic and bactericidal properties of the vinegar, which reduces the effectiveness of the bacteria. Similar to the results obtained from many other studies (Demircioğlu et al., 2018; Özbucak, 2021; Dündar et al., 2018), the fresh weight ratio decreased faster in treatments with a shorter vase life.

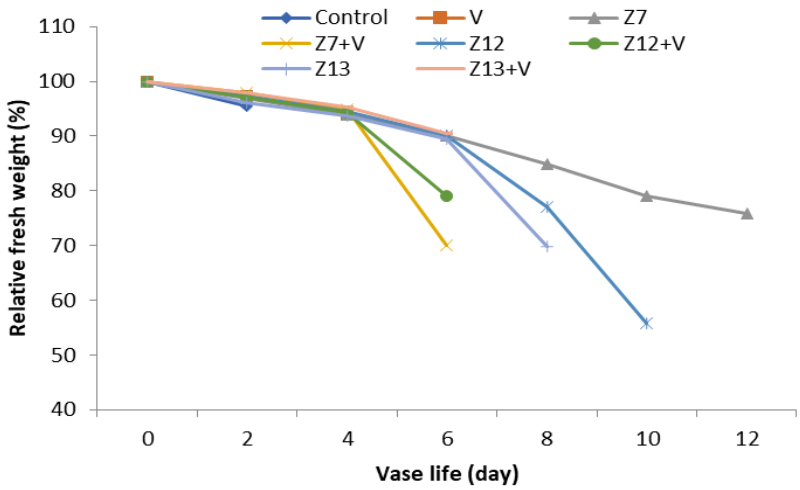

Figure 3. The relative fresh weights of cut flowers during the waiting period in the vase

5. Conclusion

All three bacteria significantly extended the vase life of gerbera cut flowers. The result revealed that bacteria can be used to extend the vase life of cut flowers. The effect of bacteria may vary depending on the plant species and the microorganism structure in the vase solution, therefore, further studies are needed to determine the appropriate bacterial strain or combination of races for each plant species. In addition, the information on the mechanism of the positive effect of some bacteria on the vase life is limited. The information obtained in the detailed studies can guide to develop new practical methods that will benefit the cut flower industry.

Compliance with Ethical Standards

Conflict of Interest

As the author of article declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

Authors' Contributions

Güzella YILMAZ: Investigation, Conceptualization, Writing - original draft. **Betül TARHANACI**: Conducting of trials. **Sabriye BELGÜZAR**: Bacteria treatments. **Zeliha KAYAASLAN**: Production of bacteria. **Kenan YILDIZ**: Statistical anlaysis, writing- review and editing.

Ethical approval

Not applicable.

Funding

No financial support was received for this study.

Data availability

Not applicable.

Consent for publication

We humbly give consent for this article to be published.

References

Anonymous (2017). Floraholland, Annual report, https://annualreport.royalfloraholland.com. Accessed to web: December, 2021.

Anonymous (2020). TUIK (Turkish Statistical Institute) Ornamental plants production inventory, www.tuik.gov.tr. Accessed on December 2, 2021.

Carlson, A.S., Dole, J.M., Matthysse, A.G., Hoffmann, W.A., & Kornegay, J.L. (2015). Bacteria species and solution pH effect postharvest quality of cut Zinnia elegans. *Scientia Horticulturae*, *194*, 71-78. https://doi.org/10.1016/j.scienta.2015.07.044

Demircioğlu, H., Dündar, Ö., & Özkaya, O. (2018). The effect of different treatments of 1-MCP doses on the storage and vase life in the rose cultivar 'First Red'. *Acta Horticulturae*, *1194*, 861-866. https://doi.org/10.17660/ActaHortic.2018.1194.121

Dündar, Ö., Demircioğlu, H., & Özkaya, O. (2018). İris kesme çiçeğinin sakkaroz içeren vazo solüsyonunda vazo ömrünün araştırılması. *Manas Journal of Agriculture Veterinary and Life Sciences*, *8*(2), 84-88.

Elhindi, K.M. (2012). Effects of postharvest pretreatments and preservative solutions on vase life longevity and flower quality of sweet pea (Lathyrus odoratus L.). *Photosynthetica*, *50*(3), 371-379. https://doi.org/10.1007/s11099-012-0053-3

HeFei, J., JiAi, L., Xiaoxu, W., Huien, Z., & Jian, G. (2010). Effect of Straw Vinegar on Vase Life and Physiological Indexes of Cut Narcissus tazetta cv. Geranium Flower. *Journal of Zhejiang Forestry Science and Technology*, *30*(4), 20-23.

Hassan, F. A. S., Ali, E. F., & El-Deeb, B. (2014). Improvement of postharvest quality of cut rose cv. 'First Red' by biologically synthesized silver nanoparticles. *Scientia Horticulturae*, *179*, 340–348. https://doi.org/10.1016/j.scienta.2014.09.053

İmriz, G., Özdemir, F., Topal, İ., Ercan, B., Taş, M. N., Yakışır, E., & Okur, O. (2014). Bitkisel üretimde bitki gelişimini teşvik eden rizobakteri (PGPR)'ler ve etki mekanizmaları. *Elektronik Mikrobiyoloji Dergisi*, *12*(2), 1-19.

Jacob, B. M., & Kim, E. (2010). Inhibiting biofilm formation of Enterobacter sp. Prevented premature withering in cut flowers. *Korean Journal of Chemical Engineering*, *27*, 1252-1257. https://doi.org/10.1007/s11814-010-0196-5

Khan, P., Mehraj, H., Taufique, T., Shiam, I. H., & Uddin, F. (2015). Chemical preservatives for increasing shelf life of gerbera. *Journal of Bioscience and Agriculture Research*, *5*(1), 30-36. https://doi.org/10.18801/jbar.050115.52

Kılıç T., & Yaman, C. (2020). Bazı kantaron ekstraktlarının gerberanın vazo ömrü üzerine etkileri. *Ege Üniversitesi Ziraat Fakültesi Dergisi*, *57*(3), 425-432. https://doi.org/10.20289/zfdergi.645539

Knee, M. (2000). Selection of biocides for use in floral preservatives. *Postharvest Biology and Technology*, *18*, 227-234, https://doi.org/10.1016/S0925-5214(99)00074-5

Lie, H., Li, H., Liu, J., Luo, Z., Joyce, D., He, S., et al. (2017). Nano-silver treatments reduced bacterial colonization and biofilm formation at the stem-ends of cut gladiolus 'Eerde' spikes. *Postharvest Biology and Technology*, *123*, 102-111. https://doi.org/10.1016/j.postharvbio.2016.08.014

Mengüç, A., Zencirkıran, M., & Usta, E. (1991). Kesme çiçeklerde vazo ömrünün uzatılması. Uludag University Journal of Agricultural Faculty, 8, 211-225.

Minerva, G., & Kumar, S. (2013). Micropropagation of gerbera (*Gerbera jamesonii* Bolus). *Methods in Molecular Biology, 11013*, 305-316. https://doi.org/10.1007/978-1-62703-074-8_24

El Sayed, A. (2018). Improving the quality of gerbera flowers after harvesting. *Middle East Journal*, *7*(3), 915-931.

Naing, A. H., Win, N. M., Han, J. S., Lim, K. B., & Kim, C. K. (2017). Role of nano-silver and the bacterial strain Enterobacter cloacae in increasing vase life of cut carnation 'Omea'. *Frontiers in Plant Science*, *8*, 1590. https://doi.org/10.3389/fpls.2017.01590

Özbucak, Ö., 2021. The effect of aminoethoxyvinylglycine (AVG) and modified atmosphere packaging (MAP) applications on the storage and vase life of narcissus (narcissus Tazetta l.) flower. Ordu University Graduate School of Natural and Applied Sciences, Department of Horticulture, Master's Thesis. (in Turkish).

Safa, Z., Hashemabadi, D., Kaviani, B., Nikchi, N., & Zarchini, M. (2015). Studies on quality and vase life of cut *Gerbera jamesonii* cv. 'Balance' flowers by silver nanoparticles and chlorophenol. *Journal of Environmental Biology*, *36*(2), 425-31.

Sharma, V., Kamra, G., Thakur, R., & Kaur, R. (2018). Extending postharvest life and keeping quality of gerbera (Gerbera jamesonii) using 8-HQS and calcium chloride with sucrose. *International Journal of Innovative Pharmaceutical Sciences and Research*, *6*(4), 21-29. https://doi.org/10.21276/IJIPSR.2018.06.04.680

Solgi, M., Kafi, M., Taghavi, T. S., and Naderi, R. (2009). Essential oils and silver nanoparticles (SNP) as novel agents to extend vase-life of gerbera (Gerbera jamesonii cv 'Dune') flowers. *Postharvest Biology and Technology*, *53*, 155-158. https://doi.org/10.1016/j.postharvbio.2009.04.003

TUIK (2018). Turkish Statistical Institute. http://www.tuik.gov.tr/. Accessed to web: December, 2021

Tuna, S. (2012). The use of some essential oils and main components to extend the vase life of cut rose and gerbera flowers. Suleyman Demirel University, Graduate School of Natural and Applied Sciences, Master Thesis, Isparta. (in Turkish).

Uzun, G., Baktır, İ., & Hatipoglu, A. (1983). Storage, Transport and Marketing Problems of Cut Flowers. Storage, Market Preparation and Transport of Horticultural Products in Turkey Symposium. C.U. Faculty of Agriculture, Department of Horticulture, Adana. (in Turkish).

Van Doorn, W.G., Zagory, D., de Witte, Y., & Harkema, H., (1991). Effects of vase-water bacteria on the senescence of cut carnation flowers. *Postharvest Biology and Technology*, *1*, 161-168. https://doi.org/10.1016/0925-5214(91)90008-Y

Van Doorn, W.G., de Witte, Y., & Harkema, H., (1995). Effect of high numbers of exogenous bacteria on the water relations and longevity of cut carnation flowers. *Postharvest Biology and Technology*, *6*, 111-119. https://doi.org/10.1016/0925-5214(94)00043-R