




SCIENTIFIC ARTICLE

The effect of some solutions on the vase life of star flowers

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Abstract

This study was carried out on the flowers of 'Le Castel' *Dahlia* (starflower) cultivated in Tokat Gaziosmanpaşa University Agricultural Research and Application Center in 2019. The study aimed to prolong the vase life of *Dahlia* flowers used as cut flowers. Deionized water (control), sucrose + deionized water, thyme oil, lavender oil, carvacrol, thymol, sodium hypochlorite, and gibberellic acid were used as vase solutions. The total vase solution uptake (g/stem), daily vase solution uptake (g/day fresh weight (FW)), proportional FW (%) and vase life (day) parameters were determined based on *Dahlia* flowers that harvested at different harvest stages (3, 4 and 5 layers). As a result; the most extended vase life was measured in the gibberellic acid treatment (8.22 days), the highest proportional fresh weight was measured in the carvacrol in the 6th day (139.78%), the highest daily solution uptake was measured in the thyme oil in 0-2 days (11.7 g/day FW) and the highest total solution uptake was measured in the thyme oil (27.5 g/stem). It was concluded that the vase life of earlier harvested flowers was longer than of late harvested.

Keywords: *Dahlia* sp., carvacrol, gibberellic acid, lavender oil, thymol.

Resumo

Efeito de algumas soluções na vida de vaso de dalias

Este estudo foi realizado com as flores da dália 'Le Castel' (starflower) cultivadas no Centro de Pesquisa e Aplicação Agrícola da Universidade Tokat Gaziosmanpaşa, em 2019. O estudo visa prolongar a vida útil dos vasos das flores *Dahlia* usadas como flores cortadas. Água deionizada (controle), sacarose + água deionizada, óleo de tomilho, óleo de lavanda, carvacrol, timol, hipoclorito de sódio e ácido giberélico usados como soluções em vasos. Os parâmetros captação total da solução do vaso (g haste⁻¹), captação diária da solução do vaso (g dia de peso fresco⁻¹), peso proporcional fresco (%) e vida do vaso (dias) foram determinados em flores de dália colhidas em diferentes estádios de colheita (3, 4 e 5 camadas). Como um resultado a vida útil mais longa do vaso foi observada no ácido giberélico (8,22 dias), o peso fresco proporcional mais alto foi medido no carvacrol no 6º dia (139,78%), a maior absorção diária da solução foi medida no óleo de tomilho em 0-2 dias (11,7 g dia de peso fresco⁻¹) e a maior absorção total da solução foi medida no óleo de tomilho (27,5 g haste⁻¹). Concluiu-se que a vida útil dos vasos das flores colhidas mais cedo era mais longa do que da colheita tardia.

Palavras-chave: *Dahlia*., carvacrol, ácido giberélico, óleo de lavanda, timol.

Introduction

Dahlias are perennial plants with tuberous roots, though they are grown as annuals in some regions with cold winters. While some have herbaceous stems, others have stems which lignify in the absence of secondary tissue and resprout following winter dormancy, allowing further seasons of growth (Saar et al., 2003). *Dahlias* have various flower shapes such as straight, cactus, semi-cactus, anemone, pompom, ball, water lily, decorative, orchid, and peony. Flowers, apart from the shades of blue, offers a full range of colors, including all of the warm colors. In addition

to this variation of color and shape, the fact that it is earlier in temperate climatic regions, but generally blooms from July to the first colds of autumn. *Dahlia* can also use as cut flowers. That is why the interest in this plant has increased in recent years. Photoperiod and average temperature have a crucial role in *Dahlia* cultivation. Because photoperiod significantly affects the size and the quality of the flower, and the number of flower buds, also in combination with temperature, on tuber development, shoot development, and flower formation (Romer, 2008). *Dahlia* needs 8-10 hours of sunlight per day to create abundant and high-quality flowers. Also, the temperature should be between

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18-24 °C during the day and 15-18 °C at night (Alp, 2008). The vase life of *Dahlia* flowers is known to vary between 6 and 8 days under room conditions, but sufficient work has not been done in this area. However, it is necessary to conduct detailed studies to prolong the life of the vase, which is considered to be essential and potentially used as a cut flower.

Sucrose in vase solution treatment can increase the mechanical rigidity of the stem and induce cell wall thickening and lignification of vascular tissue (Jafarpour et al., 2015; Abu Seman and Mohd Rafdi, 2019). So, one of the main components of solutions used to determine vase life is sucrose. Dündar et al. (2018), in their study on the iris, cut flower, 'biocide,' and vase solutions containing 1% sucrose were used and indicated that three days more vase life was provided. In the study conducted by Özer et al. (2016) to determine the vase life of *Orchis palustris* flowers, the life of the vase was determined as 14.6 days in tap water with control solution, while in solutions containing 150 mg L⁻¹ 8-HQ, 100 mg L⁻¹ AgNO₃, 80 mg L⁻¹ sodium benzoate, 50 g L⁻¹ sugar, 20 mg L⁻¹ AlSO₄, and 10 mg L⁻¹ kinetin, the vase life has determined as 23.0 days. In another study conducted to determine the vase life of *Freesia* flowers, while the vase life of the control group determined as 6.33 days, the most extended vase life has obtained from 1-MCP (4 nL.L⁻¹ + 3

hours) with 9.06 days (Zencirkiran, 2010). Mehraj et al. (2016) have concluded that sucrose-containing solutions both had a more excellent vase life than control and an increase in vase life. Vase life prolonged after applying different doses of GA₃ and BA, the vase life, fresh weight, solution uptake, membrane stability, and total soluble matter content of gerbera flowers kept in vase solution containing 2.5% ethanol and 3% sucrose (Danaee et al., 2011).

In this study; it was aimed to determine the effect of different harvest stages and solutions on the vase life of *Dahlia* (starflower), which has the potential to produce cut flowers and which has become popular.

Material and Methods

In the study, flowers of "Le Castel" *Dahlia* cultivated in the field of Agricultural Research and Application in Tokat Gaziosmanpaşa University were used as plant materials. The 3, 4, and 5 layer harvested flowers (Figure 1) were cut to 20 cm long and placed in vases capable of receiving 340 mL of the solution under room conditions (21°C ± 1). A total of 80 flowers were used in the study (Figure 2).

The beginning of the study was determined as 0 (zero) days, and the end of the study was determined as the day when 50% of the flower petals begin to wilt.



Figure 1. Flowers belonging to the "Le Castel" *Dahlia* cultivar harvested in 3 (A), 4 (B) and 5 (C) layers.



Figure 2. *Dahlia* flowers placed to vases in room conditions

Total vase solution uptake (g/stem), daily vase solution uptake (g/day FW), proportional FW (%), and vase life (day) (50% of flower petals begin to wilt) parameters were examined with two days intervals. The treatments and concentrations used in the study were presented in the Table 1.

The trial was designed as a Completely Randomized Design with three replications. Data of all parameters were recorded daily. The obtained data were subjected to the variance of analysis (One-way ANOVA) (IBM SPSS Statistic 17.0 statistics program). Duncan multiple tests ($p < 0.05$) was used for comparing means.

Table 1. Treatments and concentrations used as vase solutions

Treatment	Concentration
Deionized Water (DW) (Control) (mL)	340
Sucrose (%) + DW	4
Thyme Oil (mg/L)	150
Lavender Oil (mg/L)	150
Carvacrol (mg/L)	150
Thymol (mg/L)	150
Sodium Hypochlorite (mg/mL)	0.5/340
Gibberellic acid (ppm)	200

Results

Vase life

In the study, the effect of different harvest time (phase) treatments on the life of the starflower's vase was insignificant ($p > 0.05$), but the effect of different

vase solution treatments on the life of the vase was found significant ($p > 0.05$) (Table 2).

It was determined that the treatment of gibberellic acid had the highest (8.22 days) vase life, and the treatments of carvacrol, thymol and sodium hypochlorite had the lowest (6.89 days) on the vase life (Table 3).

Table 2. The effect of different layer numbers on *Dahlia* flower vase life (day)

Number of Layers	Average
3	7.83±0.27
4	7.33±0.20
5	7.50±0.22
Significance coefficient	0.296

±: Standard deviation

Table 3. The effect of different solutions on the life of *Dahlia* flower's vase (day)

Treatments	Average
DW (Control)	8.00±0.00ab
Sucrose + DW	7.56±2.19ab
Thyme Oil	8.00±0.00ab
Lavender Oil	8.00±0.00ab
Carvacrol	6.89±1.05b
Thymol	6.89±1.05b
Sodium Hypochlorite	6.89±1.05b
Gibberellic acid	8.22±0.67a
Significance coefficient	0.012*

*: Statistically significant at $p < 0.05$ level. ±: Standard deviation

Proportional fresh weight

When the different harvest stages (number of layers) were examined, the values obtained on the 2nd, 8th, 10th, and 12th days were found statistically insignificant ($p > 0.05$). When the values on the 4th and 6th days examined, it was found statistically significant that the proportion of fresh weight values increased as the number of layers

increased ($p < 0.05$). The 5 layer flowers had the highest proportional fresh weight (99.69%-129.46%), and the lowest proportional fresh weight measurements were determined in 3 layer flowers (79.96%-99.95%) compared to other layers. From the 6th day, it was determined that the proportional fresh weight decreases, and the deaths of the plants occurred (Table 4).

Table 4. The effect of different layer numbers on proportional fresh weight in starflower (%)

Number of Layer	2 nd day	4 th day	6 th day	8 th day	10 th day	12 th day
3	77.12±2.20	79.96±2.82b	99.95±4.31b	91.52±11.96	9.86±7.15	4.42±4.41
4	82.89±4.81	89.49±6.24ab	116.79±9.79ab	80.43±12.74	.00	.00
5	91.58±24.13	99.69±6.37a	129.46±9.23a	103.6±14.79	.00	.00
Significance coefficient	0.054	0.041*	0.043*	0.468	0.402	0.373

*: Statistically significant at $p < 0.05$ level. ±: Standard deviation

When the effect of different vase solution treatments on proportional fresh weight were examined, the difference between the findings obtained on the 2nd, 4th, 10th, and 12th days were not significant ($p > 0.05$). The difference between the results obtained on the 6th and the 8th days were found significant ($p < 0.01$). When the proportional fresh weight data were obtained on the 6th day examined, the highest proportional fresh weight values were obtained in the vase solution

containing sodium hypochlorite (139.6%) and the vase solution containing carvacrol (139.78%). The lowest proportional fresh weight ratio was determined in the vase solution containing gibberellic acid (85.56%). When the data were obtained on the 8th day examined, the highest proportional fresh weight was measured in the vase solution containing lavender oil (133.53%), and the lowest proportional fresh weight was measured in the vase solution containing thymol (52%) (Table 5).

Table 5. The effect of different vase solutions on proportional fresh weight in starflower (%)

Treatment	2 nd day	4 th day	6 th day	8 th day	10 th day	12 th day
DW	81.47±5.61	81.35±6.29	98.79±7.81bcd	128.7±9.94a	.00	.00
Sucrose + DW	88.41±11.00	101.16±14.46	136.51±21.41ab	54.31±23.00c	.00	.00
Thyme Oil	78.15±5.18	77.85±5.29	94.96±7.50cd	125.56±10.54a	.00	.00
Lavender Oil	81.32±3.14	81.3±3.75	101.85±5.00abcd	133.53±6.86a	.00	.00
Carvacrol	88.38±11.47	105.23±14.99	139.78±20.00a	56.38±24.10c	.00	.00
Thymol	82.62±2.51	91.15±3.61	126.17±8.66abc	52±26.25c	.00	.00
Sodium Hypochlorite	90.78±7.28	101.94±7.46	139.6±10.81a	65.46±26.00bc	.00	.00
Gibberellic acid	79.79±6.07	77.7±5.76	85.56±6.69d	118.85±11.64ab	.00	.00
Significance coefficient	.889	.112	.005**	.001**	.198	.440

*: Statistically significant at $p < 0.05$, **: $p < 0.01$ level. ±: Standard deviation, DW: Deionized Water

Daily vase solution uptake

There was no statistically significant effect on daily vase solution uptake ($p > 0.05$) when the different harvest stage (number of layers) treatments were examined in Table 6, there was no statistically significant effect on daily vase solution uptake ($p > 0.05$). When the effect of different vases solution treatments were examined, the effect of starflower on daily vase solution uptake was statistically significant at values measured in 2-4, 4-6,

and 6-8 days ($p < 0.01$). When we look at the data obtained in 2-4 days, the highest daily vase solution uptake was measured in the vase solution treatment containing thyme oil (6.28 g day FW^{-1}), while the lowest daily vase solution uptake was determined in the vase solution treatment containing carvacrol (2.45 g day FW^{-1}). When the data received in 4-6 days are analyzed, the highest daily vase solution uptake was determined in the treatment of vase solution containing gibberellic acid (5.42 g day FW^{-1}),

while the lowest daily vase solution uptake was obtained in the solution of sodium hypochlorite (2.18 g day FW⁻¹). When the values measured in 6-8 days were examined, the highest daily vase solution uptake was determined in

the vase solution treatment containing thyme oil (4.80 g day FW⁻¹), while the lowest daily vase solution uptake was determined in the vase solution treatment containing thymol (1.10 g/day FW) (Table 7).

Table 6. The effect of different layers on daily vase solution uptake in Starflower (*Dahlia sp.*) (g / day fresh weight)

Number of layer	0-2 nd day	2-4 nd day	4-6 nd day	6-8 nd day	8-10 nd day	10-12 nd day
3	9.74±0.27	3.93±0.34	3.11±0.26	2.43±0.46	0.11±0.08	.00
4	10.28±0.34	4.11±0.38	3.49±0.39	2.63±0.42	.00	.00
5	11.15±0.55	5.12±0.43	4.36±0.45	3.33±0.55	.00	.00
Significance coefficient	.055	.073	.063	.389	.528	.373

*: Statistically significant at p<0.05, **: p<0.01 level. ±: Standard deviation

Table 7. The effect of different vase solutions on daily vase solution uptake in starflower (g / day fresh weight)

Treatment	0-2 nd day	2-4 nd day	4-6 nd day	6-8 nd day	8-10 nd day	10-12 nd day
DW	11.1±0.94	5.29±0.21ab	4.55±0.28a	4.43±0.22a	.00	.00
Sucrose + DW	10.45±0.74	3.48±0.82c	2.26±0.52b	0.98±0.40c	.00	.00
Thyme Oil	11.7±0.68	6.28±0.70a	5.41±0.73a	4.8±0.83a	.00	.00
Lavender Oil	10.91±0.31	5.41±0.12ab	4.27±0.31a	4.01±0.34a	.00	.00
Carvacrol	9.55±0.90	2.45±0.63c	2.32±0.50b	2.1±1.13bc	.00	.00
Thymol	10.67±0.33	3.88±0.42bc	2.8±0.29b	1.1±0.56c	.00	.00
Sodium Hypochlorite	8.75±0.63	2.87±0.45c	2.18±0.44b	1.32±0.66c	.00	.00
Gibberellic acid	9.99±0.27	5.42±0.19ab	5.42±0.48a	3.6±0.47ab	.00	.00
Significance coefficient	.060	.000***	.000***	.000***	.419	.440

Statistically significant at *: p<0.05 level, **: p<0.01 level, ***: p<0.001 level. ±: Standard deviation, DW: Deionized Water

Total vase solution uptake

There was no statistically significant effect on total vase solution uptake (p>0.05) when different harvest stage (number of layers) treatments were examined in Table 8, there was no statistically significant effect on total vase solution uptake (p>0.05). However, as the number of layers increased, it was observed that total vase solution uptake increased.

When the effect of different vase solutions on total vase solution uptake was examined, it has been found statistically significant (p<0.01). When comparing between the treatments, the highest total vase solution uptake was measured in the vase solution containing thyme oil (27.5 g branch⁻¹). The lowest total vase solution uptake was determined in vase solution containing sodium hypochlorite (13.87 g branch⁻¹) (Table 9).

Table 8. The effect of different layer numbers on the total vase solution uptake in starflower plant (g/branch)

Number of layer	Average ± Standard Error
3	18.21±1.04
4	22.19±1.54
5	22.94±1.68
Significance coefficient	0.052

Table 9. The effect of different vase solutions on the total vascular solution uptake in starflower plant (g/branch)

Treatment	Average
DW	23.31±1.32ab
Sucrose + DW	22.74±3.39ab
Thyme Oil	27.5±2.82a
Lavender Oil	23.85±0.60ab
Carvacrol	16.08±2.70c
Thymol	17.76±1.35c
Sodium Hypochlorite	13.87±1.08c
Gibberellic acid	23.8±1.24ab
Significance coefficient	0.00

*: Statistically significant at $p < 0.05$, **: $p < 0.01$ level.

±: Standard deviation

Discussion

One of the most critical factors affecting the vase life of cut flowers is harvest time or ripening stage. When the effect of early harvested flowers on the vase life examined, it has been seen that, although there is no statistically significant difference, the life of the flowers harvested in the early maturity stage increases the vase life and the flower quality lasts longer than the late-harvested flowers. Since the concentration of sodium hypochlorite was high in the study, it caused premature deaths in starflower, thus negatively affecting on the total vase solution uptake and daily vase solution uptake. It was determined that the solution uptake was higher in the plants (4 and 5 layer star flowers) whose harvest stage is progressing. During the life of vase, the proportional fresh weight and vase solution uptakes on the upgrade at first, and then weight and solution uptakes on the wane with the closure of the stem of the flower branch according to the solution contents. When the parameters of vase life, proportional fresh weight, daily vase solution uptake, and total vase solution uptake were examined, it concluded that essential oils, especially thyme oil and lavender oil, had significant effects.

The most active monoterpene phenols of essential oils are known thyme oil and lavender oil (Dhifi et al., 2016), which found useful to increase the vase life of some cut flowers (Thakur et al., 2014). These results may be due to the role of thyme oil and lavender oil as antimicrobial agents (Memar et al., 2017), and they might have reduced xylem blockage and increased solution uptake, which may improve the vase life and relatively fresh weight. A positive correlation is stated between vase life, solution uptake, and relatively fresh weight in any kind of researches (Alaey et al. 2011; Amini et al., 2016). Salehi Salmi et al. (2018), in their study on cut roses, indicated that essential oils cause early flower opening and senescence of flowers. However, in our study, it is concluded that it impediments senescence

and increases the life of the vase in the flowers harvested early since it determines its effect in its layers. Sucrose acts as osmolytes and source of energy that plays a vital role to preserve the quality of cut flowers (Abu Seman and Mohd Rafdi, 2019). Mehraj et al. (2016) in their study on Gerbera (*G. jamesonii*) were used different sucrose-containing solutions and has been reported that sucrose-containing solutions maintain visual quality criteria and increase in the life of the vase. The combination of salicylic acid and sucrose also led to a significant reduction in the respiration rate and alleviated the moisture stress of cut roses to improve the vase life (Bayat and Aminifard, 2017). So, it would be useful to add sucrose to vases solutions or to use it with other essential oils. Dündar et al. (2018) used vases solutions containing 'biocide' in their study on *Iris* cut flower and had reported that they provided three days more vase life. Zencirkiran (2010), used chemicals that inhibit the synthesis of ethylene in his study in Freesia had reported an increase in the life of the vase.

Conclusions

It was concluded that the use of 'biocide' is essential for reducing the microorganisms such as bacteria, fungi and mold formed in the solutions used in the study and that new studies are needed based on the idea that ethylene inhibitors can have a positive effect on the postharvest performance of starflower.

Author Contribution

OSA: experiment idea, installation of the experiment, field analysis, data collection and analysis, **ONÖ:** installation of the experiment, analysis and interpretation of data, critical review of the article. **MG:** advisor of work, preparation and writing of the article, critical review, interpretation, translation, approval of the final version of the article.

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