



Original Research

Preservatives with or without Floral Foam Impact Postharvest Longevity of Celosia (*Celosia argentea* L.) and Tuberose (*Polianthes tuberosa* L.)

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ABSTRACT

Floral foam, a phenol-formaldehyde base product, is gaining popularity as an essential component of modern floral designs. A study was conducted to scrutinise the effectiveness of vase preservatives with or without floral foam on postharvest longevity of celosia (*Celosia argentea* L. Cristata 'Fire Chief') and tuberose (*Polianthes tuberosa* 'Single'). Results demonstrated significant differences among various tested vase solutions and floral foam. Celosia and tuberose kept without foam in vase solution containing Chrysal Clear Universal flower food depicted longest vase life (19.6 and 7.4 d), respectively. For celosia, the highest change in flower quality (8) was recorded in stems placed in 1% sucrose + 100 mg L⁻¹ salicylic acid without foam, followed by stems kept in a vase solution of 1% sucrose + 150 mg L⁻¹ citric acid with foam. Meanwhile, tuberose stems kept in Chrysal Clear Universal flower food solution exhibited the highest change in flower quality, followed by 1% sucrose + 4 mL L⁻¹ lemon juice without foam. The highest bent neck percentage (100%) was recorded in stems kept in a solution of 1% sucrose + 100 mg L⁻¹ salicylic acid and Chrysal Clear Universal flower food with or without foam, respectively. Chrysal Clear Universal flower food-treated stems without foam absorbed more water (275 and 285 mL), respectively. When kept without foam in vase solution. In summary, the overall impact of floral foam was not good in maintaining the quality of cut stems of celosia and tuberose; meanwhile, stems can be kept fresh for longer durations in distilled water for celosia and Chrysal Clear Universal flower food for tuberose without foam.

Keywords: Cut flowers, eco-friendly preservatives, longevity, postharvest quality, termination symptoms, water uptake.

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INTRODUCTION

Oasis floral foam, a phenol-formaldehyde base product, is gaining popularity as an essential component of modern floral arrangements. Floral arrangements can be easily rotated using floral foam as a base material (Smithers-Oasis, 2023). Floral oasis foam is now used as a water source for floral arrangements and a support medium in the floriculture industry (Trestrail et al., 2019). Floral foam is a premium support provider for floral designs created in different directions (Etheredge et al., 2023). The duration of time cut flowers can stay fresh in a floral arrangement varies significantly depending on the cut flower cultivar (Ranwala, 2009; 2022).

Floral preservatives are effective solutions containing carbohydrate sources which assist in prolonging postharvest

longevity. Three basic ingredients in preservatives are sugar, acidifier and biocide (Fatima et al., 2022). Nutritional compounds, as postharvest solutions, are gaining popularity in the supply chain management of ornamentals. Cut blooms are placed in floral solutions to minimize postharvest losses and increase longevity (Asif et al., 2016). Sugar promotes bud opening and functions as food for the flowers. For cut blooms, 1-2% sugar solution is optimal. Meanwhile, for flowers harvested at the closed or partially opened bud stage, viz., gladiolus, lilies, stock, tuberose, tulips, iris, and amaryllis, a higher concentration of sugar is required for bud opening (Ahmad et al., 2014). Vase life may vary depending on the type of floral arrangement being made. Designs created for special occasions, like weddings, may only last 12 to 24 hours (Faloon, 2021). According to an experiment's findings, coir pouches are more appropriate for floral design work for short-term occasions (Dubey and Mishra, 2018).

Floral foam is crucial in floral designs as it provides stability, hydration and arrangement structure. It holds water, keeps flowers hydrated, extends lifespan, and allows for precise placement of stems, making complex designs possible. Foam-based floral designs can rotate in all directions as arrangements become simpler using foam (Feldmann, 2019). Nowadays,

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phenol-formaldehyde foam has been applied worldwide in the floral industry as a water source and as a support medium for stems in fresh flower designs (Trestrail et al., 2019). Foam is widely used in floral arrangements; therefore, research has been conducted to scrutinise the impact of various preservatives, with or without foam, on cut celosia and tuberose stems saturated with distilled water or preservatives. For many cut flower species, vase life was reduced when cut stems were kept in floral foam, irrespective of floral preservatives (Ahmad et al., 2014). Therefore, a study was conducted to find out the best preservative solution with or without foam for cut celosia and tuberose stems to get a longer vase life with good quality. It was hypothesized that use of preservatives along with foam would improve efficiency of the floral foam through provision of carbohydrates required by the stems after harvest to remain fresh for longer durations. Moreover, floral foam would act as a substrate for holding various floral arrangements. This study highlighted the significance of both floral foam as substrate for holding cut stems in arrangements and floral preservatives for extending postharvest longevity to enjoy the beauty of cut stems for extended periods rather than using styrofoam sheets for this purpose which cannot hold moisture and cut stems wilt too quickly when used along with these sheets in floral arrangements.

MATERIALS AND METHODS

A study was carried out at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan, during 2023 on (*Celosia argentea* L. Cristata 'Fire Chief') and (*Polianthes tuberosa* L. 'Single'). A hundred fresh stems of each species were harvested in the morning and shifted to the floriculture lab, within 1 h of harvest and processing was performed.

Stems Processing

On arrival at the laboratory, lower leaves were removed. Stems were allowed to rehydrate for two hours and kept in tap water. Fresh solutions were prepared, including treatments viz., control (distilled water), 1% sucrose + 150 mg L⁻¹ citric acid, 1% sucrose + 100 mg L⁻¹ salicylic acid, 1% sucrose + 4 mL L⁻¹ lemon juice and Chrysal Clear Universal flower food along with and without foam. After fine cutting, floral foam was soaked in solutions for 15-20 minutes. When the foam was saturated with the solution, it was inserted into jars and flowers after recutting lower stem ends to a uniform length after tagging and weighing. It was then inserted in jars with or without foam. The experimental setup was done according to a Completely Randomized design (CRD), factorially, including vase preservatives and floral foam with five replicates, each jar containing two stems assessed at the temperature set at 22±2°C and 50±10% of humidity along with 12 h of light. Data were collected on changes in stem fresh weight (g), dry weight (g), water uptake (mL), initial and final EC, initial and final pH, vase life, change in flower quality and termination symptoms, viz., (bent neck, stem end rot).

Measurements

Data were collected regarding the effects of treatments on the

following quality parameters:

Change in fresh weight (g)

Weight was recorded on day-0 of the experiment, moreover on 7th day using electric weighing balance (A & D Gulf, Model DM-305F). Their difference was calculated between two stems and means were worked out.

Fresh weight (g) = Initial weight – Final weight

Change in flower quality

Stem quality was calculated, a scale having quality, 0-9 as 0=bad, 6=medium, 9 best. From each replication five stems were observed by three independent judges and their averages were calculated.

Change in flower quality = Final value – Initial value

Dry weight (g)

At the end of experiment, each stem was taken out for dry weight. After shade drying, stems kept in drying oven at 72°C for 48 h. Stems were weighed and means were computed.

Water uptake (mL)

Water intake was measured as: Water uptake (mL) = (S₀-S₇), where S₀ represents the quantity of vase water supplied in each jar on day 0 and S₇ represents the amount consumed on day 7.

Change in solution electrical conductivity EC (µS.cm⁻¹) and pH

Solution EC and pH were measured on day 0 of the experiment and at 50% stem termination using an electrical conductivity meter (Hanna, HI9811-5). The difference was calculated, and the means were worked out.

Vase life (d)

Vase life was taken from initiation day till stems exhibited > 50% termination symptoms. Vase life was recorded in days, and their average was worked out (Ahmad et al., 2013).

Termination symptoms

Termination symptoms, viz., bent neck (%) and stem end rotting (%), were accessed when they were exhibited on ≥50% of stems, and the average was calculated. Stems showing symptoms were numbered 1 = Yes and 0 = No. Data were collected in percentages.

Statistical approach

Data were subjected to analysis of variance (ANOVA) procedures using General Linear Models procedures, and means were separated using Fisher's least significant difference (LSD) test at P≤0.05 (Steel et al., 1997).



Figure 1: Pictorial representation of treatment comparisons for cut celosia and tuberose with or without floral foam.

RESULTS AND DISCUSSION

Celosias, while placed in Chrysal were recorded as having the most significant change in stem fresh weight (18.6 g) without foam and (18.4 g) with foam. Changes in fresh weight were also associated with water intake. Stems, when uptake more water, remain fresh for longer durations, as depicted in (Table 1). The findings from a study align with these results, which indicated that floral foam maintained the postharvest longevity of cut flowers by keeping stems hydrated for longer durations (Etheredge et al., 2023). Postharvest longevity of (19.6 d) was calculated in Celosias placed without foam (19 d) with floral foam in Chrysal solution (Fig. 1). The shortest vase life (11.6 d) was observed in stems placed in 1% sucrose along with salicylic acid. Foam is widely utilised in floral designs. Regardless of preservatives, the longevity of numerous cut blooms was reduced when immersed in floral foam (Ahmad et al., 2014). In comparison to stems kept in a control solution, utilization of commercially available floral foods without floral foam increased the postharvest longevity of stems. When used with commercial preservative solutions, foam extends vase life by around 5 days (Fig. 2A). These results support earlier findings that floral foam shortens the postharvest life of several cut blooms (Ahmad et al., 2013). The greatest percentage of termination symptoms were also recorded when stems were placed with foam; this may be due to residual salts generated as

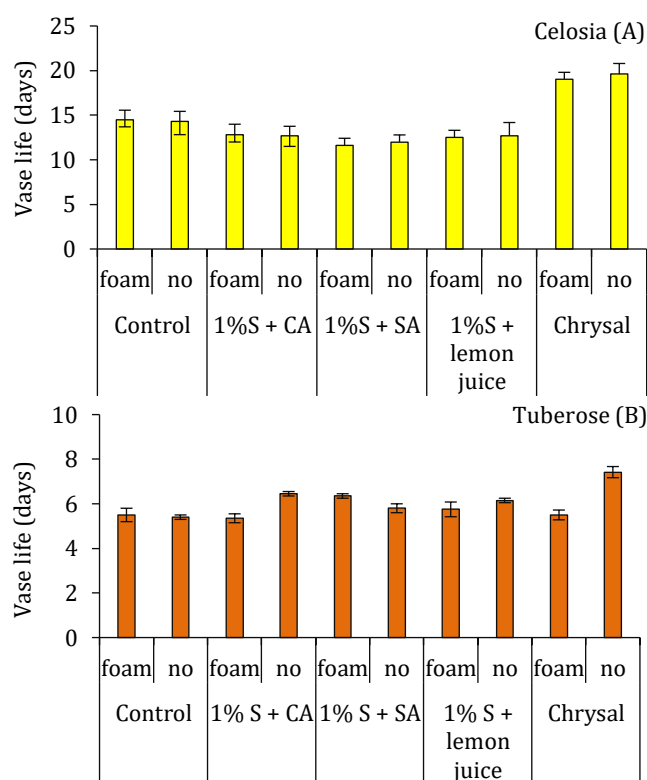


Figure 2: Effect of various preservative solutions with or without floral foam on vase life of tested cut flowers. Bars represent means of 10 stems $\pm$ S.E. Control (distilled water), 1% S= 1% Sucrose, CA = Citric acid, Chrysal = Chrysal Clear Universal Flower food.

resulting in the utilisation of foam, which may cause increasing electrical conductivity of the foam-containing solutions. Using an acid-catalysed reaction, floral foam is made to have a pH of 3.0-3.5. The decreased vase life in foam-based solutions may be caused by a rise in the vase's EC and pH, causing more stem end rotting and stem bending (Favero et al., 2017).

Tuberose stems exhibited the longest vase life (7.4 d) kept in Chrysal followed by citric acid (6.4 d) and lemon juice (6.1 d) when placed without floral foam with vase solution (Fig. 2B). Floral foam deteriorated the quality of cut stems by causing a more bent neck (100%) with 1% sucrose + salicylic acid, followed by Chrysal Clear Universal flower food. Stem end rot (70%) was recorded as the highest in stems kept in lemon juice solution without foam. Chrysal-treated stems showed no symptoms of stem end rot with or without foam (Table 2). Preservatives are more efficacious in extending longevity ornamentals. Similar findings were found in cut snapdragon stems, which exhibited a vase life of (5-6 d) and can stay fresh for (12 d) more days in floral preservatives. Applying flower food to nurture cut flowers can minimize senescence and maintain flower quality from grower to consumer (Fatima et al., 2022). Preservative solutions are more adequate compounds to increase longevity and quality management of cut stems (Mochizuki-Kawai et al., 2018). The utilisation of floral foam with preservative solutions resulted as an effective postharvest

Table 1: Evaluation of different preservative solutions with or without floral foam on postharvest handling and longevity of cut celosia (*Celosia argentea* L.). Data represents means of ten stems.

Treatments (vase solutions)	Foam	Change in fresh weight (g)	Water uptake (mL)	Change in flower quality (1-9)	Change in EC	Change in pH	Vase life (days)	Bent neck (%)	Stem-end rot (%)
Control (distilled water)	Yes	15.7 ab	0 e	1.2 c	0 d	0 c	14.5 b	70 ab	30 bcd
	No	15.8 ab	242 b	1.0 c	344 b	0.4 b	14.3 b	20 d	50 abcd
1% sucrose + Citric acid	Yes	14.5 ab	0 e	3 bc	0 d	0 c	12.8 b	70 ab	50 abcd
	No	14.4 ab	162 d	1.0 c	816 a	0.5 b	12.7 b	60 bc	80 a
1% sucrose + Salicylic acid	Yes	12.1 b	0 e	6 a	0 d	0 c	11.6 b	100 a	80 a
	No	12.2 b	156 d	8 ab	887 a	0.4 b	12 b	50 bcd	70 ab
1% sucrose + Lemon juice	Yes	15.1 ab	0 e	1.5 c	0 d	0 c	12.5 b	40 bcd	60 abc
	No	15.3 ab	206 c	1.2 c	455 b	1.4 a	12.7 b	60 bc	40 abcd
Chrysal Clear	Yes	18.4 a	0 e	1.0 c	0 d	0 c	19 a	30 cd	20 cd
Universal flower food	No	18.6 a	275 a	1.0 c	141 c	1.2 a	19.6 a	30 cd	10 d
Significance ^z	(VS)	0.0028	<0.0001	0.0007	<0.0001	0.0042	<0.0001	0.0048	0.0021
	Foam (F)	NS	<0.0001	NS	<0.0001	<0.0001	NS	0.0202	NS
	(VS×F)	NS	<0.0001	NS	<0.0001	0.0042	NS	0.0156	NS

^z Change in fresh weight, flower quality, EC and pH = Final value – initial value

^y Means separation within columns by Fisher's LSD $P \leq 0.05$.

^x P values were obtained using general linear models (GLM) procedures of Statistix (version 8.1, analytical software) for significant effects vase solutions with or without floral foam on (*Celosia argentea* L.).

Table 2: Evaluation of different preservative solutions with or without foam on postharvest handling and longevity of cut tuberose (*Polianthes tuberosa* L.). Data represents means of ten stems.

Treatments (vase solutions)	Foam	Change in fresh weight (g)	Water uptake (mL)	Change in flower quality (1-9)	Change in EC	Change in pH	Vase life (days)	Bent neck (%)	Stem-end rot (%)
Control	Yes	12.8 abcd	267.5 a	2.9 de	0.0 c	0.0 ab	5.4 d	35 b	10 cd
(distilled water)	No	11.6 bcd	71 c	3.9 cd	366 a	0.1 a	5.5 cd	40 b	35 bc
1% sucrose + Citric acid	Yes	20.8 ab	85 bc	3.6 cde	0.0 c	-1.4 d	5.3 d	10 b	40 b
	No	23.0 a	270 a	4.4 bc	237 ab	-0.1 abc	6.4 b	20 b	10 cd
1% sucrose + Salicylic acid	Yes	12.1 bcd	96.5 bc	2.5 e	0.0 c	-2.2 e	5.8 bcd	100 a	30 bc
	No	8.1 cd	289.5 a	4.1 bc	173 b	-0.3 bc	5.8 bcd	80 a	70 a
1% sucrose + Lemon juice	es	20.8 ab	104 b	3 de	0.0 c	-0.4 c	5.7 bcd	10 b	10 cd
	No	16.5 abc	271.5 a	5.1 ab	198 b	-0.1 abc	6.1 bc	10 b	0.0 d
Chrysal Clear	Yes	6.1 cd	95 bc	2.5 e	0.0 c	-1.1 d	5.5 cd	100 a	40 b
Universal flower food	No	4.8 d	285 a	6 a	22 c	-1.2 d	7.4 a	100 a	0.0 d
Significance ^z	(VS)	0.0006	NS	0.059	0.0102	<0.0001	0.0061	<0.0001	0.0028
	Foam (F)	NS	<0.0001	<0.0001	<0.0001	<0.0001	0.0011	NS	NS
	(VS×F)	NS	<0.0001	0.0102	0.0102	<0.0001	0.0001	NS	NS

^z Change in fresh weight, flower quality, EC and pH = Final value – initial value

^y Means separation within columns by Fisher's LSD $P \leq 0.05$.

^x P values were obtained using general linear models (GLM) procedures of Statistix (version 8.1, analytical software) for significant effects vase solutions with or without floral foam on (*Polianthes tuberosa* L.).

strategy to increase vase life (Balas et al., 2006). The water quality, floral preservative, floral foam and vase (control) were tested on roses and alstroemeria. Decarbonised water significantly enhanced postharvest life in vases for (1.5 d) in commercial floral preservative; an increasing quantity of Chrysal treated stems were recorded with the longest vase life with/without foam (Neumaier et al., 1997). Leachates from floral foam waste (FFW) microplastic may affect water, causing more toxicity to flowers than leachates from other kinds of plastic (Ebaid et al., 2023). These findings are in accordance with

the impacts of floral oasis foam with organic preservatives studied on cut roses (*Rosa × hybrida* L.). Floral foam minimized postharvest longevity in cut rose cultivars viz., 'Freedom' and 'Charlotte' did not affect the senescence in either of the tested cultivars (Ahmad et al., 2014). Indigenous preservatives are easily accessible to consumers and assist in lengthening vase life (Ahmad et al., 2016; Tork et al., 2022). Floral foam is a synthetic product that may contain chemicals or salts that influence stems, blocking stem ends and reducing water intake. Reduced water intake may cause petal wilting, necrosis and, consequently,

reduced stem quality. However, foam can be used in floral designs for short durations. Foam immersed in water has been found to reduce the vase life of cut flowers, including roses and campanula (Favero et al., 2017).

CONCLUSION

Among tested preservatives, stems kept in Chrysal Clear Universal flower food performed best and had the longest vase life for both species. However, the floral foam had no significant effect on cut celosia stems while reducing tuberose vase life. Therefore, our findings indicated that floral foam may be used for handling cut stems but only with preservatives, as floral foam saturated with water alone was not useful. Therefore, it is concluded that floral foam may be used for a short duration soaked in Chrysal Clear Universal flower food solution for the commercial handling of these species by the florists.

RECOMMENDATIONS

Floral foam may be used only when immersed with preservatives such as Chrysal Clear Universal flower food or 1% sucrose + citric acid.

DECLARATION OF COMPETING INTERESTS

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION STATEMENT

Tazkia Hussain: Collected data, data analysis, manuscript 1st draft writeup editing and formatting. **Iftikhar Ahmad:** Conceived the idea provided technical guidance, and technically reviewed the manuscript. **Huda Hameed:** Collected data, **Mariam Irshad:** Assisted in data collection. **Bilal Khalid:** Helped in formatting and review. All authors have read and approved the final version of the manuscript.

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ETHICAL STATEMENT

Not applicable.

AVAILABILITY OF DATA AND MATERIAL

All data is published in this research article.

INFORMED CONSENT

Not applicable.

CONSENT FOR PUBLICATION

The authors have submitted consent to publish this research

article in the 'Journal of Horticulture Sciences and Technology'.

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REFERENCES

- Ahmad, I. and Dole, J.M. 2014. Postharvest performance of cut marigold, rose, and sunflower stems as influenced by homemade and commercial floral preservatives. *Turkish Journal of Agriculture*, 38(6): 916-925. <https://doi.org/10.3906/tar-1402-31>
- Ahmad, I., Dole, J.M., Clark, E.M. and Blazich, F.A. 2014. Floral foam and/or conventional or organic preservatives affect the vase-life and quality of cut rose (*Rosa × hybrida* L.) stems. *The Journal of Horticultural Science and Biotechnology*, 89(1): 41-46. <https://doi.org/10.1080/14620316.2014.11513046>
- Ahmad, I., Dole, J.M., Saleem, M., Khan, M.A., Akram, A. and Khan, A.S. 2013. Preservatives and packaging material have an impact on the post-harvest longevity of cut *Rosa hybrida* L. 'Kardinal' flowers. *Journal of Horticulture Science and Biotechnology*, 88(3): 251-256. <https://doi.org/10.1080/14620316.2013.11512963>
- Ahmad, I., Dole, J.M., Schiappacasse, F., Saleem, M. and Manzano, E. 2014. Optimal postharvest handling protocols for cut 'Line Dance' and 'Tap Dance' Eremurus inflorescences. *Scientia Horticulturae*, 179: 212-220. <https://doi.org/10.1016/j.scienta.2014.09.031>
- Ahmad, I., Dole, J.M. and Blazich, F.A. 2014. Effects of daily harvest time on postharvest longevity, water relations, and carbohydrate status of selected specialty cut flowers. *HortScience*, 49(3): 297-305. <https://doi.org/10.21273/HORTSCI.49.3.297>
- Ahmad, I., Saleem, M. and Dole, J.M. 2016. Postharvest performance of cut 'White Prosperity' gladiolus spikes in response to nano- and other silver sources. *Canadian Journal of Plant Science*, 96(3): 510-516. <https://doi.org/10.1139/cjps-2015-0281>
- Asif, M., Ahmad, I., Qasim, M. and Ahmad, R. 2016. Effect of pulsing with various preservatives on postharvest performance of cut *Polianthes tuberosa* L. 'Single' spikes. *Pakistan Journal of Agriculture Science*, 53(2). <https://doi.org/10.21162/PAKJAS/16.5436>
- Balas, J., Coronado, P.A.G., Silva, J.D. and Jayatilke, M.P. 2006. Supporting post-harvest performance of cut-flowers using fresh-flower-refreshments and other vase-water-additives. In: da Silva, J.A.T. (ed.). *Floriculture, Ornamental and Plant Biotechnology: Advances and Topical Issues* (vol. 1). Global Science Books Ltd., Japan. pp. 612-629.
- Dubey, N. and Mishra, V. 2018. Cushioning materials for fruits, vegetables, and flowers. In: Siddiqui, M.W., Rahman, M.S. and Wani, A.A. (eds.). *Innovative Packaging of Fruits and Vegetables: Strategies for Safety and Quality Maintenance*. Apple Academic Press, New York, USA, pp. 275-313.
- Ebaid, R., Wang, Q., Faisal, S., Li, L. and Abomohra, A. 2023. Valorization of floral foam waste via pyrolysis optimization for enhanced phenols recovery. *Chemosphere*, 310:136-758. <https://doi.org/10.1016/j.chemosphere.2022.136758>
- Etheredge, C.L., DelPrince, J. and Waliczek, T.M. 2023. US consumer perceptions and willingness to pay for sustainable environmental practices in the floral industry. Final report, Mississippi State University and the Texas State University, USA.
- Faloon, S. 2021. Making a wedding bouquet and keeping it fresh. https://www.ehow.com/how_7734796_making-wedding-bouquetkeeping-fresh.html, accessed on 14 July 2023.
- Fatima, K., Ahmad, I., Dole, J.M., Ahmad, N., Asif, M., Ziaf, K. and Fatima, K. 2022. Folk floral preservatives extend postharvest longevity of *Eustoma grandiflorum* L. *Scientia Horticulturae*, 301: 111-132. <https://doi.org/10.1016/j.scienta.2022.111132>
- Favero, B.T., Pace Pereira Lima, G. and Dole, J.M. 2017. *Curcuma alismatifolia* vase life. *Ornamental Horticulture*, 23(1):

101. <https://doi.org/10.14295/oh.v23i1.989>
- Feldmann, R. 2019. Floral foam: The impact on our environment. *Flowers Magazine*.
<https://flowersmagazine.com.au/2019/11/27/floral-foam/>, accessed on 27 November 2019.
- Mochizuki-Kawai, H., Kotani, I., Mochizuki, S. and Yamakawa, Y. 2018. Structured floral arrangement program benefits in patients with neurocognitive disorder. *Frontiers in Psychology*, 9: 13-28. <https://doi.org/10.3389/fpsyg.2018.01328>
- Neumaier, D., Haas, H.P. and Roeber, R. 1997. Longevity of cut flowers as influenced by water quality and floral foam. *Acta Horticulturae*, 482: 77-82.
- Ranwala, A. 2009. How to conduct fresh cut flower vase life experiments. *Flora Life*, 11:1-2.
- Ranwala, A. 2022. Vase life study results of cut roses with flower food. <https://floralife.com/2022/01/26/vase-life-study-resultsof-cut-roses-with-flower-food>, accessed on 15 July 2023.
- Smithers-Oasis. 2023. FibreFloral design media safety data sheet. https://oasisfloral.com.au/wpcontent/uploads/2021/12/FibreFloralTM_Design_Media_SDS.pdf, accessed on 18 May 2023.
- Steel, R.G.D., Torrie, J.H. and Dicky, D.A. 1997. Principles and Procedures of Statistics: A Biological Approach (3rd Ed.). McGraw Hill Book Co. Inc., New York, pp. 328-345.
- Stuenkel, J., Anderson, N.O. and Goodman, E. 2025. The effect of Oasis® floral foam on the postharvest performance of perennial flax cut flowers. *HortTechnology*, 35(2): 223-232. <https://doi.org/10.21273/HORTTECH05598-25>
- Tork, D.G., Anderson, N.O., Wyse, D.L. and Betts, K.J. 2022. Perennial flax: A potential cut flower crop. *Horticulture Science*, 57: 221-230. <https://doi.org/10.21273/HORTSCI16098-21>
- Trestrail, C., Walpitagama, M., Hedges, C., Truskewycz, A., Miranda, A., Wlodkowic, D., Shimeta, J. and Nugoda, D. 2019. Foaming at the mouth: Ingestion of floral foam microplastics by aquatic animals. *Science of the Total Environment*, 705: 1-13. <https://doi.org/10.1016/j.scitotenv.2019.135826>