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COMPARATIVE STUDY ON VASE LIFE EXTENSION STRATEGIES IN COMMERCIAL CUT FLOWERS: A REVIEW

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ABSTRACT

Vase life of cut flowers holds significant aesthetic, commercial, and economic importance, particularly in reducing postharvest losses, which are typically estimated to be around 30–40%. The duration of freshness retention, which may range from a few days to several weeks depending on the flower species, is a key determinant of floral shelf life. This shelf life can be significantly extended through the use of various additives in the holding solution, such as acidifiers, biocides (which eliminate microbial growth that blocks xylem vessels and impedes water uptake), biostimulants, and carbohydrate sources (which serve as an energy supply for metabolic activities). Both organic and inorganic substances can be employed to enhance vase life. Organic additives include natural plant extracts and essential oils such as peppermint oil, thyme oil, clove oil, geranium, eucalyptus, mentha oil and *Calotropis* extracts. In contrast, inorganic compounds commonly used include citric acid, 8-hydroxyquinoline citrate (8-HQC), 8-hydroxyquinoline sulfate (8-HQS), quaternary ammonium salts, aminooxyacetic acid (AOA), thiabendazole (TBZ), silver thiosulfate (STS), molecular hydrogen, and silicon.However, the application of certain inorganic chemicals raises environmental concerns due to the potential generation of reactive oxygen species (ROS) such as peroxide and superoxide radicals. These ROS can adversely affect plant cellular metabolism and may pose broader ecological risks if not managed properly.

Key words : Vase life, Organic/ Inorganic substances, Reactive oxygen species (ROS), Biostimulants.

Introduction

Flowers are a unique gift of that almighty to mankind. There are different flowers in this nature which blooms at their own specific time like some are of winter, some are of autumn and some are of summer. Their different forms, shape and size always attracts people towards them. Beside flowers their foliage, dried forms and different products made from them also proved to be useful for people. But their limited time period of blooming and vulnerability towards attack of pests and microbes are always a matter of concern, due to which they lost their shine and appearance as a consequence they fetch lower price as compared to fresh flowers. To avoid early wilting of flowers, attack of microbes and maintain their appearance for some more time the concept of vase life came under study.

Short postharvest vase life is one of the major challenges faced in the cut flower industry. Vase life longevity is a crucial factor influencing consumer preference (Da Silva, 2003). Maintaining the quality and extending the vase life of cut flowers is essential to ensure market acceptability. With the increasing transportation of cut flowers over long distances, maintaining freshness under such conditions has become even more critical. These extended transport and storage conditions often compromise the quality of cut flowers. Therefore, keeping quality is a key parameter in assessing the commercial value of cut flowers in both domestic and export markets. The primary factors contributing to the reduced vase life of cut flowers include nutrient deficiencies, bacterial and fungal contamination (Kazemi *et al*., 2011), water stress-induced wilting and vascular blockage (Alaey *et al*., 2011). Bacterial growth in vase water can lead to blockage of xylem vessels at the cut stem surface (Ferrante *et al.*, 2007), which interferes with water uptake. This vascular blockage results in water deficit and wilting during the vase life period (Knee, 2000; Van Ieperen *et al.*, 2002).

What is vase life?

Vase life usually refers to the amount of time a cut flower or foliage remains its appearance in a vase which usually contains some acidifiers, sugars, biocides or germicide etc. in it for increasing the conspicuous time which a customer always looks for. Some examples of vase life of cut flowers are Rose (HT) and tuberose for 7 to 10 days, chrysanthemum 1 to 2 weeks, carnation (3 weeks), Gladiolus (6-12 days), orchid (3 to 4 weeks) etc.

Novel vase solutions : These are the vase solutions which are evolved through novel ideas (Hosalli and Hebbal, 2022).

Start of vase life : Vase life of a flower is just started from the period when it was put into test solution/water after cutting from the plant (Pun and Ichimura, 2003).

Factors affecting vase life

- Pre-harvest stage (Genetic and Environmental conditions)
- Harvest factors (Time, stage and its method) just after cutting the flower from the stem they are placed in water to prevent air embolism.
- Post harvest handling procedures *i.e.* floral preservative solutions which results in a more fresh appearance of flowers for some days.

Ethylene effect : This growth regulator is responsible for senescence and early wilting of flowers causing appearance of flowers to be degraded, to prevent this an inhibitor called 1-MCP can be used.

Most suitable environmental conditions for post harvest evaluation which was approved at 2nd international symposium are (Reid and Kofranek, 1980):

- Temperature: 20+/- 2 degree Celsius
- Light intensity: 1000 lux
- Source of light: Cool white fluorescent tubes
- Day length: 12 hours (7am-7pm)
- Relative humidity: 60-70%
- Gas concentration in ethylene: Maximum 0.05 microlitre/ litre
- Room CO_2 Evaluation: 200-400 microlitre/ litre
- Air velocity at bench level: It should not exceed 0.5m/sec

Transpiration and Intensity

It is generally accepted that an increase in transpiration rate leads to a reduction in vase life of cut flowers due to the loss of water in the form of vapors from plant organs such as petals and stems. Transpiration intensity, a component of this process, is influenced by environmental factors such as temperature, humidity, wind speed, and direction. However, a notable exception to this understanding was reported by Zeljkoviæ *et al.* (2021), who found that transpiration intensity also depends on the composition of the holding solution used for cut flowers. Interestingly, the highest transpiration intensity was observed in flowers that exhibited the longest vase life, and vice versa.

This observation highlights that the type of vase solution can significantly influence water relations in cut flowers. For example, flowers kept in commercial flower food solutions demonstrated a longer vase life than those kept in simple sucrose solutions. This was particularly evident in species such as calla lily and gerbera, where vase life is closely associated with stem posture. In these flowers, the phenomenon of "bent neck" is a critical postharvest issue affecting their marketability, and maintaining stem firmness is essential from a floriculture and aesthetic standpoint (Elgimabi and Ahmed, 2009).

Durability and transporting qualities affecting vase life (Chaanin, 2003)

Due to the long periods of transportation from the cultivation areas the demand for a long vase-life is very high. Normally the varieties should have a vase-life of at least 12–14 days, but there are varieties on the market with 18 days vase-life and more. Varieties with fragrance, however, have a vase-life of 8–10 days. The tests for vase-life at the breeders level are done under uniform conditions with lighting of 3 W m^{-2} for 12 h, temperature of 20 °C±1°C and a relative air humidity of 60±5%. These type of conditions are found especially useful for group of roses like sweetheart (In the bud stage and are still able to fully open) and Large-flowered varieties have to be cut half open otherwise they will not fully open and testing of varieties against botrytis disease is evaluated and its effect on the vase life of flower was evaluated.

Storage and Preservation affecting the vase life (Liu *et al.*, 2024)

Storage and preservation has become an important link in the production of commercial flowers as it balances the supply of cut flowers in the off-season and improves the ornamental value of cut flowers with the help of variety selection and cultivation management which ultimately affects vase life in determining marketability of flowers which was affected by postharvest physiological changes like respiratory metabolism, cell moisture, cell membrane stability, pigments, carbohydrate levels and antioxidant systems which are affected by some exogeneous substances. Therefore, it is important to create new, efficient preservation technologies to increase the vase life of cut flowers and improves ornamental quality and economic benefits.

Factors for floral preservative solutions (Nguyen and Lim, 2020)

A) Bud opening: Low sugar concentration helps in early bud opening of flowers.

B) Pulsing treatment: It helps in improving flower life and petal colour by controlling osmotic regulation and can be done with chemicals like STS, 8-HQC, 8-HQS, $CaCl_{2,}$ AOA, TBZ etc.

C) Holding solution (Vase solutions): It contains a combination of Sugar, PGR's, germicides, ethylene inhibitors, mineral salts and organic acids. Sugars provide energy for respiration while germicides kill microbes and prevent clogging of cut stems.

The main concern regarding the synthetic chemicals like STS, TBZ and AOA etc. is that they are harmful in nature and their use should be minimised to avoid associated health consequences (Singh *et al*.,2022).

The vase life of ornamental plants was observed to improve significantly upon the addition of various organic and inorganic substances, biostimulants, and essential oils to the vase solutions. These additives played a crucial role in maintaining a balance between water uptake, retention, and loss, thereby sustaining stem turgidity. This, in turn, helped prevent the disruption of cellular membranes and inhibited the entry of microbes through the lower cut ends of the stems. By reducing microbial contamination and avoiding xylem vessel blockage, the treated flowers were able to retain freshness for an extended duration compared to untreated controls. Examples of vase life of some Cut flowers:

- **Gladiolus:** In this crop when natural leaf extracts of CPLE i.e. *Calotropis procera* leaf extract are used at 2% then it has shown a maximum vase life of 14.50 days (Akhtar *et al*., 2021).

- **Carnation :** when this crop is treated with salix extracts and mentha leaf extracts (SE and ME) and salicylic acid (SA) @ 50 and 100mg/l have increased the vase life significantly (Ardakani *et al*., 2022).

Fig. 1: Gladiolus.

Fig. 2 : Carnation.

Also 5% Hydrogen nanobubble water (HNW) increases the vase life of it by decreasing the activities of nucleases and proteases and also decreases the activity of Reactive oxygen species (Li *et al*., 2021).

- **Tuberose :** In this crop extension of vase life was a major problem, so a combination of 2% sucrose+ 200mg/l $AgNO_3$ + 300mg/l HQS + 25mg/l citric acid have shown an increase in vase life of tuberose upto 10 days (Naznin, 2015).

- **Rose :** This flower shows a vase life of 12.0 days when treated with Hydrogen peroxide @600 microgram but application of sodium hypochlorite @ 200mg/l shows a vase life of 10.0 days in the cultivar "samourai" (Meral *et al*., 2024).

Also, MgH_2 can be used to increases the vase life of roses by contributing H_2 which increases the water uptake of plants but it is sensitive to NO(Nitric oxide), which inhibits its function (Li *et al*., 2021).

- **Peony :** Usually vase life of this flower ranges

Fig. 3 : Tuberose.

Fig. 4 : Rose.

Fig. 5 : Peony.

from 3 to 15 days depending on cultivar, but addition of silicon(Si) to the holding solution increases its vase life upto some extent because it was able to depress excessive water loss and limits bacterial development creating water balance between water uptake and water loss (Song *et al.*, 2021).

- **Gerbera :** Here use of sucrose in the vase solution gave a maximum vase life of 9.2 days in the cultivar "dune" followed by citric acid with a vase life of 8.4 days (Maitra *et al*., 2024).

Citric acid usually does not increase vase life of flowers and its lower concentrations are desirable but its impact on decreasing microbial count upto some extent can not be ignored (Jowkar *et al*., 2012).

- **Narcissus:** Here longest vase life of 10.8 days was observed with the application of 1mM Gamma-Aminobutyric acid (GABA) because it modulates the phenylpropanoid pathway and metabolizes the reactive oxygen species (Krush and Rastegar, 2022).
- **Chrysanthemum:** Here the longest vase life of

Fig. 6 : Gerbera.

Fig. 7 : Narcissus.

Fig. 8 : Chrysanthemum.

36.50 days was observed with a concentration of thyme oil@ 500mg/l or clove oil @250mg/l (El-Sayed and El-Ziat, 2021).

- **Dendrobium Orchid:** Application of peppermint essential oil@ 50 or 100 microgram/mililitre in combination with 4% glucose increases the vase life upto 28 days when mixed with holding solution (Teerarak *et al*., 2024).
- **Lisianthus :** It is a new generation cut flower which shows a case life of 31 days when sucrose is applied @ 60g/l in the combination of sucrose with citric acid (Kiamohammadi, 2011).
- Also, when cultivation methods like soil and hydroponic system are compared than it wass

Fig. 9 : Dendrobium Orchid.

Fig. 10 : Lisianthus.

found that petal color metrics are reliable indicators of senescence having potential for improving quality control and extending vase life in floriculture industry (Know and Heo, 2024).

- **Anthurium:** Holding of these flowers in 5% sucrose + 5% ginger extract recorded maximum vase life of 17.33 days due to the lower microbial load in solution which prevents stem plugging and increases water uptake which ultimately increases vase life(Roopa *et al.*, 2021).
- **Alstroemeria:** Here pulsing of flower with 6% Sucrose in combination with citric acid % 100 ppm solution gave resulted in a vase life period of 9.00 days. Citric acid maintains availability of essential nutrients while sucrose provides energy source for performing essential functions like maintenance of turgor pressure and delaying senescence (Hadapad *et al.*, 2024).
- **Heliconia:** Very little information is available in this flower related to its vase life, but still it can be increased by the application of a 10% sucrose in combination with Hydraflor 100 @ 0.5g/l, which was pulsed for 24 hours and shows a vase life of 22.8 days due to the great water consumption, lower fresh weight loss and greater floral opening (Alvarado and Baltazaar-Bernal, 2021).

Fig. 11 : Anthurium.

Fig. 12 : Alstroemeria.

- **Lily:** One of the most beautiful flower, in this flower a combination of gibberellic acid @ 450mg/l and humic acid @ 400mg/l have shown a vase life of 13.66 days due to the stabilization of cell membrane (Moghadam and Asil, 2021).

Another example included was that foliar application of a biostimulant i.e. Biovita (seaweed) @ 2ml/l exhibits a highest vase life of 12.60 days which helps in the regulation of consumption of sugar through the formation of an intermediate zinc, so helps in prolonging the vase life of plant (Archana *et al.*, 2023).

- **Gomphrena :** In this flower application of N, P and K @ 200, 75 and 100kg/ha respectively resulted in a vase life extension upto 6.98 for N, 6.47 for P and 6.56 days for K is measured. Nitrogen is necessary for production of amino acids (Proteins), which maintains appearance of flowers, while phosphorus helps to maintain healthy flower tissues and in last potassium maintains the turgidity of flowers (Varma *et al.*, 2023).
- **Goldenrod:** In this flower effects of storage period (0, 5, 10 and 15 days) on the vase life was seen and it was found that the longest vase life of cut goldenrod flowers was at no-storage

Fig. 13 : Heliconia.

Fig. 14 : Lily.

Fig. 15 : Gomphrena.

Fig. 16 : Goldenrod.

application condition. However, although storing for 5 days decreased the vase life of the flowers by 20% compared to the control, it was concluded that cut goldenrod flowers could be stored for 5 days (Aydin and Kirbay, 2022).

- **Lisianthus, Snapdragon, Stock and Zinnia**: These flowers shows a vase life of 22.1 and 12.7 days for lisianthus and stock respectively when placed in a homemade floral preservative solution of a combination of C-IS i.e. Citric acid @400mg/l + 0.007ml/l Isothiazolinone for a period of 48 hours, while Snapdragon and zinnia shows a vase life of 22.3 and 16.3 days, respectively when applied with a combination of C-QA solution *i.e.* Citric acid @400mg/l + Quaternary ammonium salts @0.5ml/l for 48 hours, it is due to the continuous placement of C-IS resulted in higher fresh weights and had highest solution uptake which maintains freshness for more time while C-QA has greater control in respect of microbial count (Ahmad and Dole, 2014).
- **Asparagus species**: vase life of asparagus species was found different for different species when they are grown in shadehouse with 70% light exclusion and after harvest submerged in water packed in plastic bags and stored for 2 weeks in corrugated fibre board boxes (CFB's) held at 4^{o}C, after that the stems were held in glass containers filled with deionized water, and it was found that the maximum vase life of 24.4 days was observed for A. densiflorus 'Myers' species and minimum vase life of 6.2 days was observed for *A. pseudoscaber* species. Meanwhile, the symptoms for vase life terminations were recognised by chlorosis i.e. yellowing and cladophyll drop i.e. Abscission (Stamps *et al*., 2005).
- **Vase life of new cut flowers (**Dole *et al.*, 2020): Stems of new cut flowers were pre treated with either a commercial hydrating solution or deionized (DI) water for 4 h and placed in either a commercial holding solution or DI water for 44 h. Holding preservatives increases the vase of genera Agastache, antirrhinum, digitalis, eustoma, filipendula, helianthus, lilium, penstemom, perovskia, physostegia and tagetes, whereas commercial hydrators increased the vase life of *Agastache*, *Hibiscus* and *Tagetes*. Meanwhile, a similar vase life of about 10 days was found for the genera campanula, coreopsis, daucus, dianthus, digitalis, helianthus, lilium, monarda, rudbeckia, salvia, stokesia, tagetes and veronica.

Furthermore, on the other hand, genera like eupatorium 'Baby joe' and Tagetes 'Oriental gold' had a vase life of about 21 days which was comparatively more than the other cultivars.

Genera like: Campanula 'Champion pro deep blue', Dianthus 'Deep maxine' and 'Magenta bicolor', Digitalis 'Plum gold', *Eustoma* 'Rosanne 1 Deep Brown' and 'Rosanne 1 Green', *Helianthus* 'EH16-13', Hibiscus 'Mahogany Splendor', Tagetes '888 Deep Gold', 'Falcon Yellow', 'Garland Orange' and 'Storm Gold', *Rudbeckia* 'Viette's Little Suzy' and *Veronica* 'Charlotte' had a vase life of 14 to 21 days.

Penstemon Arabesque Appleblossom, *Perovskia* 'Longin' and *Saliva* 'Burgundy Candles' had a vase life of less than 7 days.

Vase life of selected perennial species (Janowska *et al*., 2022):

- ***Hemerocallis hybrida* 'Agata'**: Conditioning of the leaves of Hemerocallis with meta-methoxytoplin and dimethylethylammonium gibberellinate at both concentrations of 1-ethyl quinine gibberellinate @ 100mg/dm^3 and acetylcholine gibberellinate @ 50mg/dm^3 resulted in a vase life of 7-9 days.
- ***Limonium latifolium***: The application of acetylcholine gibberellinate @ 50 and 100mg/dm3 and 1-dodecyl acetycholine gibberellinate resulted in its longest vase life of the species after a conditioning of 4 hrs.
- ***Heuchera hybrida* 'Chocolate ruffles'**: Its conditioning with benzyladenine, meta-methoxytoplin and its riboside at a concentration of 50 and 100mg/dm^3 extended the vase life by 9.5-51.3 days.

Vase life of ornamental plants can be increased through addition of following substances (Patel *et al*., 2018).

- **Essential oils**: Examples include Thyme oil, Lavender oil, Rosemary oil, Geranium oil, Eucalyptus oil, Mint oil, Ajowan oil, Savory oil, Corriander oil, Dill oil, Artemisia oil, turmeric oil, cumin, anise, Myrtus, Zataria, clove etc. having high amount of phenolic acids like carvacrol, thyme and eugenol which are antioxidant in nature.
- **Extracts:** Guava, apple, Piper betel, Jatropha curcas, tobacco, galanda, Annona, calotropis, sage, balm etc.
- **Natural Floral preservative:** Coconut water and coconut milk.
- **Artificial preservatives**: Chrysal and Floral life
- **Anti- Desiccant floral preservative**: Sucrose because it decreases the stomatal pore size and hence helps in water conservation.
- **Biostimulants / Phytostimulants**: These are substances which are applied to plants, seeds or soil to improve plant growth and health. Example sare-Bion,Agro-Mos, Quartz, Ca- Fosfitotal and K-Fosfitotal. These maintain the stem quality and vase life of Heliconia (Sardinha *et al*., 2019).

Biostimulants more specifically include Humic acid, Fulvic acid, seaweed extracts, Hydropro-gold, Biovita, beneficial bacteria, beneficial fungi, chitosan, protein hydrolysates, amino acids and inorganic compounds like silicon.

Foliar application of Humic acis increases chlorophyll content, rate of photosynthesis, fresh weight and flower size which together leads to an increase in vase life of chrysanthemum flowers (Fan *et al*., 2015).

- **Coagulants:** Examples are- Polyamines, Melamine and Potassium aluminium sulphate (Alum) specially used for increasing the vase life of *Jasminum Sambac* flowers (Acero *et al*., 2016).
- **Hormones and growth regulators:** Gibberellins, Kinetins etc. e.g. Methyl Jasmonates improves the vase life of cut peony flowers (Gast, 1999).
- **Acidifying agents:** Like Citric acid, Ascorbic acid and salicylic acid etc. lowers the ph of holding solution and increases the vase life of flowers for e.g. pre and postharvest application of Salicylic acid improves vase life, fresh weight, relative water content, petal water content and suppresses the water loss in Alstromeria cut flowers (Soleimany-Fard *et al*., 2013).
- **Germicides/ Antimicrobial Compounds :** Examples are- $AgNO_3$, 8-HQC, 8-HQS, Maleic acid, Methanolic and Ethanolic leaf extracts of *Jatropha curcas, Andrographis paniculate* and *Psidium guajava* (Guava), e.g. leaf extracts of *A. paniculata* reduces the microbial population and increases the vase life of flowers (Rahman *et al*., 2014).

Conclusion

The longevity of ornamental plant life in a vase is important because it determines market prices and satisfaction of consumers. Growers and retailers need to find new technologies for increasing their display life and factors affecting it like water quality, environmental conditions, ethylene sensitivity, transpiration intensity, colorimetric methods, preservation, durability and transportation etc. helps in determining the future market prices of the ornamentals, which plays important role in ornamental industry. The use of substances like sugars, biocides, biostimulants, coagulants, acidifiers, flower food solutions etc. followed with their proper storage helps to increase vase life from few days to few weeks. Research and novel technology adoption with good and sound effect on environment are evolving continuously to meet new market trends for fetching more prices and build up a high quality and that's the main motive behind it.

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