



P-ISSN: 2349-8528

E-ISSN: 2321-4902

www.chemijournal.com

IJCS 2020; 8(3): 2375-2379

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Received: 28-03-2020

Accepted: 30-04-2020

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A review on the effect of storage methods and packaging material on the post-harvest longevity of cut flowers

Neelam ThakurDOI: <https://doi.org/10.22271/chemi.2020.v8.i3ah.9568>**Abstract**

Flowers are beautiful and very complex commodity which deteriorates within a few days to a week only. To keep the cut flower in vase appealing to consumer for longer period, floriculture researchers have standardized various post-harvest technologies for various flowers. These post-harvest technologies of cut flowers includes the precooling, standardization of pulsing solutions, selecting the appropriate storage methods and storage temperature, choosing the suitable packaging material and standardization of holding solution for a particular cut flower. This review is an insight into the various storage methods such as cold storage and wet storage and numerous packaging materials (Polyethylene, Polypropylene and newspaper *etc.*) suggested by various researchers for particular cut flower. This will gives the base for the further post-harvest studies of cut flowers.

Keywords: Wet storage, dry storage, packaging, cut flowers and post-harvest**Introduction**

Cut flower is individual flower or inflorescence that has been cut from the plant bearing it often with some stem and leaves. They are typically used in vase displays, flower bouquet, indoor decoration and wreaths, etc. Significant commercial market and supply industry exists for commercial cultivation of cut flowers. Important cut flowers in market are rose, chrysanthemum, carnation, tulip, lily, gerbera, fressia, cymbidium, alstroemeria and gypsophilla etc. In India leading flower producing states are Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh, West Bengal and Chhattisgarh etc. in order of their contribution. The area under flowers was reported 324 thousand ha with total flower production of 2785 thousand metric in 2017-18 (Anon, 2018) [3].

Cut flowers are highly perishable commodities and vulnerable to various postharvest losses. Market losses in the cut flower owing to inefficient postharvest storage and packaging are estimated around 20-40% (Jawaharlal *et al.*, 2006) [14]. Storage of flowers is crucial to facilitate the adjustment of flowers to market demand, enables the accumulation of large quantities of flowers for distant shipment and extends sale period for high value flowers (Goszczyńska and Rudnicki, 1988) [11]. Solo storage of flower is sometime deleterious, so proper packaging and pulsing become obligatory.

Factors affecting flower longevity

1. Normal maturation and aging,
2. Food depletion,
3. Wilting water stress and xylem blockage
4. Bruising and crushing
5. Fluctuating temperatures during storage and transit
6. Accumulation of ethylene
7. Sub optimal cultural practices or condition
8. Color change bluing
9. Attack by bacteria and fungi
10. Poor water quality (Goszczyńska and Rudnicki, 1988) [11]

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Factors affecting post-harvest life of spike during storage Temperature

Temperature influences the metabolic activities of plants. Low temperature during storage or shipment period reduces the entire metabolism in the tissues, slows down the respiration, transpiration, ethylene production and action and retards the multiplication of bacteria and fungi.

1. Water

Water is essential to maintain the turgidity of spikes of cut flower. Slightly acidic water checks the growth of harmful bacteria and fungi.

2. Air exchange

The associated biochemical and physiological changes associated with the post-harvest quality of flowers are largely affected by O₂ and CO₂ levels. So altering the levels of these two can enhance the vase life by large extent.

3. Microbial activity

Fungi and bacteria cause rotting and thereby deteriorate flower quality. Effective management of these pathogens can extend shelf life of cut flower to a large extent. Celikel and Reid, 2002^[7] confirmed that vascular plugging in cut flowers caused by bacterial colonies development is the major reason for lesser vase life.

4. Ethylene

Ethylene is one of important plant growth regulator. It plays an important role in hastening the senescence of the flower. There are a number of inhibitors of ethylene action are used such as, Silver Thiosulfate, 2,5- Norbornadiene and 1-Methylcyclopropene (1-MCP). Exogenous ethylene in a large number of cut flower can be controlled by using the 1-MCP (Celikel and Reid, 2002)^[7].

Hence, throughout entire storage period it is necessary to maintain uniform temperature, relative humidity, air circulation and sanitation of storage room.

Why we have post harvest losses?

There are several reasons associated with post harvest losses. These losses may natural as due to aging of cut flower or due to poor handling. Some reasons pertaining to poor handling and infrastructure are as follow:-

1. Inadequate transportation
2. Poor storage facilities
3. Lack of cold storage facilities
4. Inadequate transport infrastructure to facilitate controlled temperature
5. Lack of pack house
6. Careless harvesting
7. Rough handling

Those caused by later can be reduced to a great level by having proper infrastructure and effective handling procedure and personnel.

Why storage of cut flowers is necessary?

Storage of cut flower enables the adjustment of flowers to market demand. It also helps to accumulation of large quantities of flowers for distant shipment. Storage extends the sale period for high value flowers, make their availability during the lean period and prevent surplus production from degradation. This all safeguard the interest of farmers.

Storage Methods

Storage of flowers can be of following types.

1. Cold storage
 - a) Wet storage
 - b) Dry Storage
2. Controlled atmosphere storage (CAS)
3. Low pressure storage (LPS)
4. Modified atmosphere storage (MAS)

Cold storage: It facilitates adjustment of flower stock to the market demand. It is most economical and widely used method of flower storage.

S. No.	Crop	Pre-cooling temperature
1	Anthurium	13 °C
2	Alstroemeria	4 °C
3	Chrysanthemum, Cymbidium, Paphiopedilum	-0.5 – 4 °C
4	Gladiolus	4 °C
5	Rose	1-3 °C
6	Carnation	1 °C
7	Gerbera	4 °C

Source: Janick, 2011

Wet storage: In this method spikes are dipped in water or some preservative solution during storage. The cut flowers are kept in water or preservatives solution at 3-4 °C for a short time. Carnation, Gerbera, Lily & Snapdragon can be best stored under this method (Singh *et al.*, 2007)^[24].

S No.	Flower	Storage Temperature	Maximum Storage period
1	Rose	2 °C	10 Days
		4 °C	4 Days
2	Gladiolus	0.5-1.6 °C	10 Days
3	Gerbera	4 °C	3-4 Weeks
4	Lily	1 °C	4 Days
5	Tuberose	4-5 °C	4 Days

Source: - Janick, 2011

Dry storage: In this method fresh flowers are wrapped in plastic packaging or any other suitable packaging material to prevent the loss of moisture after harvesting & grading. Prior to storage flowers are treated with fungicide and pulsed with floral preservatives (Singh *et al.*, 2007)^[24].

Controlled atmosphere storage (CAS)

This is a storage method with lower level of O₂ with a higher level of CO₂ (up to 4%) in gas cool chambers with cooling system. This led to reduction in the physiological processes consisting of respiration and production of ethylene. (Singh *et al.*, 2009)^[4, 23]

Modified atmosphere storage

Modified atmosphere storage (MAS) is less cumbersome and more economical than the controlled atmosphere and low pressure storage. The storage response of flowers depends upon the maintenance of positive water balance in the stem and ultimate concentration of CO₂ and O₂ inside the packages during storage (Singh *et al.*, 2009)^[4, 23]. Considerable variations occur among flower species in their response to modified atmosphere conditions during storage (Goszczyńska and Rudnicki, 1988)^[11]

Packaging material

A number of packaging material are used while placing flower spike for storage most frequently used are Polypropylene (PP), Low Density Polyethylene (LDPE), PO (Polyolefin), Cellophane, Butter paper, Newspaper, Banana leaves etc.

Qualities of Packaging Material

The requirement of attributes of packaging material with respect to floral product are flower quality maintenance, water loss reduction, protection from physical injury, convenient to use, traceability and make the floral product easy to handle in transportation. The qualities of packaging material are strong enough, resistant to moisture, low cost or reusable, and finally friendly with packing line machinery. Selection of a suitable packaging material to create an optimal passive modification of CO₂ and O₂ levels is of utmost importance for storage of cut flowers (Patil and Singh, 2009) [19].

Storage and packaging of some cut flowers

Kumar *et al.*, (2010) [15] found pulsing with sucrose 5% and 8-HQC (150ppm) best to improve the quality of cut roses. Using Al₂(SO₄)₃ (300ppm) in place of 8-HQC also gives better results. Roses are cold stored best at 4 °C for 24 hr. Best packaging material is CFB sheet followed by butter paper.

Shiva and Bhattacharjee, (2006) [21] found that pulsing increase the vase life of cut flower spikes significantly and the vase life decreased significantly with increasing storage duration.

Bala *et al.*, (2009) [4] concluded that increase in duration of wet storage decreased the degree of bud opening and correspondingly, final diameter of the flower decreased with increase in storage duration. The vase life of the buds also decreased with increase in the storage durations. Buds showed an acceptable vase life of 4.30 days after 9 days of storage as compared to 6.46 days in control. Vase life decreased significantly after 9 days. The absorption of water by cut flower stem is decreased with the increase in the storage. It can hence, be inferred that cut stems of rose cv. First Red could be stored for 9 days with vase life of more than 4 days. They suggested that refrigerated dry storage was better than refrigerated wet storage.

Experiment conducted by Akbudak and Murat, (2013) [2] suggested that to maximize the beneficial effects of MAP on cut flower quality, O₂ and CO₂ levels need to be adjusted to harvest with post-harvest handling temperatures. Cut roses respond positively to low O₂. Cut stems in the control showed higher daily water consumption than those in MAP.

Jawaharlal *et al.*, (2006) [14] recommended Low gauge poly film (100 gauge) as best packaging material followed by butter paper out of newspaper, cellophane paper, butter paper, corrugated thin sheet. Flower stalk length, girth, diameter of flower and fresh weight of stalk all were superior in poly film packaging. They found promising results by covering base with 25 ppm 8-HQS.

Chrysanthemum

Most of the Standard chrysanthemums are placed in sleeves (50 gauges) and packed in display boxes measuring 91 x 43 x 15cm. They are placed in the boxes according to the grades. For bulk packing of the spray chrysanthemums, 10, 15 or 20 stems are placed in sleeves & packed in box measuring 80 x 50 x 23cm. It is wrapped in plastic and stored for 6-8 week at 0.5 °C. Recommended temperature for truck shipment is 2-4

°C. Azordin (600 ppm) treatment for half hour protect from pest and diseases. Pillow of corrugated paper under neck of large bloom prevents mechanical damage. Pulsing with different solution shows better keeping quality yet sucrose 2% + AgNO₃ (25 ppm) + citric acid (75 ppm) and sucrose (2%) +8 HQC (500 ppm) are recommended best holding solution for bud opening and increased vase life of chrysanthemum. Slight acidic and biocidal nature of 8-HQC increase its efficiency as floral preservative (Gupta *et al.*, 2006) [12].

Gladiolus

Storage of gladiolus below 1.6 °C proven detrimental and it also fail to open when taken out of long term storage. Though, 6-9 days storage is satisfactory, yet can be stored for 30 days under low pressure storage technology. Spikes when harvested for local market are submerged in water. Perforated card board or wooden box of 120 X 60 X 30 cm size is used for packing. It is recommended to put immediately on water after reaching distant market. Refrigerated van can keep quality for long distant shipment. Nelofar and Paul, (2008) [17] reported that with increasing storage duration the quality and vase life of gladiolus decrease significantly.

The spikes of gladiolus dry-stored in polyethylene sleeves showed considerable decline in post-storage vase life and opening of florets, with an increase in storage duration. The post-storage vase life, however, varied in different cultivars (Singh *et al.*, 2006) [22].

Polypropylene sheet reported to maintain high CO₂ and low O₂ level. Spikes harvested when 1-2 bud start showing colour exhibit less vase life then those when 4-5 start showing colour for 7 and 14 days but more for 21 days storage. Spikes of later could be dry stored with PP 100 and PP 200 for 7 days with vase life 7.67 and 6.67 days respectively (Singh *et al.*, 2008) [10]. The spikes wrapped in cellophane and stored at 4 °C for 48 hr exhibited better vase life than those wrapped in newspaper, Reason being decrease in water loss and a build-up of high relative humidity inside the cellophane packages Beura and Singh, (2003) [5].

Floret failed to open after 21 and 28 days of storage, floret size decline with increase in storage duration and was more in spikes stored in PP100 and PP 200 and maximum number of floret opening also decreased with storage duration (Singh *et al.*, 2008) [10]. The effect of wet packing of gladiolus on physiological loss in weight (g), vase life and floret size of gladiolus cv. 'Sylvia' and reported that the low temperature with a very and high relative humidity is favourable for decreasing the post-harvest losses in most of the cut flowers. The wet storage with sucrose at 3% for 48 hours was effective when wrapped with polyethylene at low temperature (10 °C) storage. However, the wet storage with sucrose 4% for 48 hours in storage as well at room temperature maintains the turgidity of flowers with the higher per cent floret display and vase life and also reduce the extra cost input for maintain the low temperature (Munsi *et al.*, 2011) [9].

Effect of polyamines in post harvest life of gladiolus

Polyamines (Spermine, spermidine) are reported to significantly improve the fresh weight, uptake of vase solution, flower opening and vase life. The pH of vase solutions was found lower and they improve the membrane stability index (Dantuluri *et al.*, 2008) [10].

Narcissus

Vase life of Jonquil and Paperwhite cultivars of Narcissus decreased with increasing range of storage temperature. Dry

storage of narcissus was found better at early stage but wet storage of narcissus was found better later. Respiration increase exponentially over temperature range 0-12.5 °C and vase life decrease exponentially with increasing storage temperature (Cevallos and Reid, 2000) [8].

Carnation

Carnation is very sensitive to post harvest treatments and longevity can be doubled if handled carefully. It can be stored normally for 2 weeks but under low pressure condition upto 90 days. Stage of harvesting has great impact on ability to storage duration without deterioration of quality. Light bud stage can be stored for 20-24 week at 0-1.1 °C where as partial open for 6-10weeks and fully open for 2-3 week. Flowers are packed in bunches and sleeved in plastic sheets or newspaper as per requirement of customer. Generally cardboard boxes having 122cm X 50cm X 30cm dimension are used. 10ppm 8-HQS + 2% sucrose was found best for improving longevity and quality, increased flower diameter, solution uptake and reduced fresh weight losses. Aluminium sulphate in vase solution is responsible for increasing vase life along with sucrose as it is known to check microbial growth. Combination of biocide and ethylene inhibitor alone or with sucrose tends to increase vase life, and improve flower quality (Bhatia *et al.*, 2002) [5].

Gerbera

Use of germicide like 8-HQS reduce the population of microbes, and sucrose alone increase microbe population. Maximum vase life win gerbera as recorded in sucrose 3%+ 8-HQS 200 ppm or Sucrose 3% + Aluminium Sulphate 200 ppm along with better freshness, colour and least bent neck (Chakrabarty *et al.*, 2011) [9].

Effect of different storage and pulsing

In all the three species of Iris, the enhanced vase life was recorded in scapes kept at 5 °C under dry or wet storage as compared to the corresponding scapes kept at higher temperatures (10 °C and room temperature). The postharvest performance of scapes was found to be better in scapes transferred to sucrose as compared to the corresponding scapes transferred to distilled water (Ahmad *et al.*, 2013) [1].

Stock (*Matthiola incana*)

A vase solution containing Hydroxyquinoline sulfate (HQS), 0.005% CCC (chlormequat), and 5% sucrose (Proflovit) improved the life of stock flowers. Improved vase life of flower pretreated with STS, and when the flowers were held in a vase solution containing HQS as biocide and 1% sucrose. Stock stems might have lasted longer in the foam due to the lower pH, which would have inhibited the growth of stem plugging bacteria. As with many cut flower species, continuous sucrose provision was beneficial to stock flowers by increasing vase life, darkening flower color, and increasing the number of buds opening. 1-MCP, a gaseous inhibitor of ethylene action, prevented the deleterious effects of ethylene on stock flowers (Regan and Dole, 2010) [20].

Jasmine (*Jasminum sambac*)

The greatest problem in jasmine is that flower cannot be preserved beyond a day. There is huge demand for jasmine to Sri Lanka and other South East Asian countries. Treatment with boric acid 4% packaging in polypropylene 60 µ packaging in corrugated fiber board boxes with 4% ventilation and storage at a temperature 7-8 °C and RH 80-

85% has extended the shelf life to 192.32 hr (Thamaraiselvi *et al.*, 2010) [26].

Daisy (*Aster amellus*)

Daisy flowers showed maximum solution uptake, fresh weight and vase life in 0.4% 8-HQS (116.7%) and minimum fresh weight was found in distilled water. Other treatment used was Aluminium Sulphate (0.2 and 0.4%), 8-HQS (0.2%), sucrose (1 & 2 %), citric acid (100ppm) silver nitrate (0.003%) and distilled water (Patil *et al.*, 2009) [19].

Conclusion

Storage and packaging are indispensable for advancing vase life and sustaining quality of cut flower. Significant improvement among various cut flower species have been reported by manipulating stage of harvesting, supplying preservative and alternative food material, proper packaging, and storage conditions. Proper planning of production and post harvest handling is of keen importance in safeguarding the interest of farmers/ producer. Diligent extension of research work to farmer is the need of hour.

References

- Ahmad SS, Tahir I, Shahri W. Effect of different storage treatments on physiology and postharvest performance in cut scapes of three *Iris* species. Journal of Agricultural Science and Technology. 2013; 15:323-331.
- Akbudak B, Murat S. 1-MCP, low O₂ and high CO₂ reduce disorders and extend vase life of "Rosalin" gerberas during storage. Acta Agriculturae Scandinavica, Section B - Soil & Plant Science. 2013; 63(2):176-183.
- Anonymous. National Horticulture Board Database. Ministry of Agriculture and Farmers Welfare, Government of India, 2018.
- Bala M, Kumar R, Singh K, Singh R. Post-harvest behaviour of Rose cv. First Red under wet as well as dry conditions. Journal of Ornamental Horticulture. 2009; 12(2):135-137.
- Beura S, Singh R. Effect of storage temperature and wrapping material on postharvest life of gladiolus cultivar Her Majesty. Journal of Ornamental Horticulture New Series. 2003; 6(4):322-327.
- Bhatia S, Gupta YC, Dhiman SR, Thakur KS. Studies on pulsing and storage of Carnation flowers. Journal of Ornamental Horticulture, 2002; 5(2):24-26.
- Celikel FG, Reid MS. Storage temperature affects the quality of cut flowers from the asteraceae. Hort Science, 2002; 37(1):148-150.
- Cevallos JC, Reid MS. Effect of temperature on the respiration and vase life of Narcissus flowers. Acta Horticulturae, 2000; 517:335-341.
- Chakrabarty S, Chandra B, Munsu P, Roychowdhury N. Effect of water temperature on rehydration and vase life of gerbera 'Calcutta Orange'. Acta Horticulturae. 2011, 886:
- Dantuluri VS, Raju, Misra RL, Singh VP. Effects of polyamines on post harvest life of Gladiolus spikes. Journal of Ornamental Horticulture, 2008; 11(1):66-68.
- Goszczynska DM, Rudinicki RM. Storage of cut flowers. Horticultural Review, 1988; 10:35-62.
- Gupta VN, Chakrabarty D, Datta SKD. Influence of different holding solutions on the postharvest behavior of cut flower: Chrysanthemum (*Dendranthema grandiflora* Tzelve). Journal of Ornamental Horticulture. 2006; 9(1):80-84.

13. Janick J. Horticultural Reviews. 11st Ed. John Wiley and Sons. 2011, 460.
14. Jawaharlal M, Babu MD, Indhumati K. Post-harvest packaging techniques for *Dendrobium* hybrid Sonia-17. Journal of Ornamental Horticulture, 2006; 9(1):16-19.
15. Kumar J, Mirza A, Pal K. Effect of combined treatments of pulsing, pre-cooling and packaging on quality and vase life of cut Rose cv. First Red. Journal of Ornamental Horticulture, 2010; 13(2):107-111.
16. Munsu P, Chakrabarty S, Roychowdhury N. Effect of storage conditions and packaging supplemented with different solutions (wet packing) on vase life of Gladiolus. Acta Horticulturae. 2011; 886:349-355.
17. Nelofar, Paul TM. Post-harvest management of gladiolus. Journal of Ornamental Horticulture. 2008; 11(1):69-71.
18. Patel T, Singh A. Effect of different modified atmosphere packaging (MAP) films and cold storage temperatures (5, 10 and 15 °C) on keeping quality of gerbera (*Gerbera jamesonii*) flowers. Acta Horticulturae. 2009; 847:353-358.
19. Patil VS. Effect of preservatives on post harvest life of Daisy (*Aster amellus* L.) flowers. Journal of Ornamental Horticulture, 2009; 12(1):54-58.
20. Regan EM, Dole JM. Post-harvest handling procedures of *Matthiola incana* 'Vivas Blue'. Postharvest Biology and Technology, 2010; 58:268-273.
21. Shiva KN, Bhattacharjee SK. Effect of pulsing and wet storage in carbohydrates during the course of senescence in cut Rose. Indian Journal of Horticulture, 2006; 69(4):419-423.
22. Singh A, Kumar J, Kumar P. Improvement of flower quality and vase life of low temperature stored Gladiolus spikes by pre-storage pulsing and vase solution treatments. Journal of Ornamental Horticulture. 2006; 9(4):266-269.
23. Singh A, Kumar J, Kumar P. Influence of sucrose pulsing and sucrose in vase solution on flower quality of modified atmosphere low temperature (MALT)-stored gladiolus cut spikes. Acta Horticulturae, 2009; 847:129-138.
24. Singh K, Singh P, Kapoor M. Effect of vase life on keeping quality of standard Carnation (*Dianthus caryophyllus* Linn.) cut flowers. Journal of Ornamental Horticulture. 2007; 10(1):20-24.
25. Singh K, Singh R, Kumar R. Effect of different polymeric films on modified atmosphere storage of Gladiolus cut spikes. Journal of Ornamental Horticulture, 2008; 11(1):49-53.
26. Thamaraiselvi SP, Jawaharlal M, Ganga M, Varadharaju N. Packaging technology for long term storage of Jasmine (*Jasminum sambac* Ait.) flowers. Journal of Ornamental Horticulture. 2010; 13(3):171-181.