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A Nirmala
Assistant Professor, Department of Horticulture, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

M Vijayalakshmi
Assistant Professor, Department of Horticulture, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

J Aruna Kumari
Professor, Department of Bio Chemistry, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

Corresponding Author:
A Nirmala
Assistant Professor, Department of Horticulture, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

Packaging materials and storage temperatures on Shelf life of flower crops: A review

A Nirmala, M Vijayalakshmi and J Aruna Kumari

Abstract
Flowers are a beautiful, complex and delicate commodity that degrades in a matter of couple of days to a week. Various post-harvest technologies for different flowers have been standardised by researchers in order to maintain the flower in vase appealing to consumers for a prolonged period of time. Precooling, standardisation of pulsing solutions, selecting the best storage method, temperature, packaging material, and standardisation of the holding solution for a specific flower are all these includes post-harvest technologies. This review delves into the packing materials such as polyethylene, polypropylene, and newspaper suggested by various studies for distinct flowers that store well at different temperatures. This will lay the groundwork for future post-harvest research on flowers.

Keywords: storage temperature, packaging methods, flowers and post-harvest

Introduction

Flowers are commonly used in vase displays, indoor decoration, flower bouquets, and wreaths, among other things. Commercial cultivation of flowers has a sizable commercial market and supply industry. Some important flowers available in the market are chrysanthemum, rose, tulip, gerbera, lily, cymbidium, carnation, fressia, alstroemeria and Gypsophilla etc. Leading states in flower producing in India are Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh, West Bengal and Chhattisgarh etc. in order of their contribution.

Because of perishable nature of flower, there is significant post-harvest loss which is ranging from 30 to 50%. Qualitative losses, such as consumer acceptance of fresh produce, is more problematic to quantify than quantitative losses. As a result of improper post-harvest handling, quantitative losses occur throughout the market chain (Bhattacharjee, 2006) [1]. This loss is higher in India, because of a lack of information about 'post-harvest handling' of flowers. The main cause of post-harvest loss is a lack of post-harvest management (PHM) and commodity processing infrastructure. These post-harvest losses can only be reduced if flowers are handled, packaged, stored, marketed, and processed properly.

The key to reducing flower post-harvest loss is for those involved in flower harvesting to be well-trained so that they can harvest and handle the flowers gently. The flowers are harvested at their peak of maturity, which is the second-best thing. Finally, immediately after harvest, the cut flowers should be kept in water to avoid air embolism and transported to a packaging house using a cold chain facility. To avoid water and weight loss, harvest the loose flower and immediately bring it to Shade.

Factors impacting the flower longevity

1. Normal maturation and aging
2. Food exhaustion
3. Water stress and xylem blockage
4. Crushing and bruising
5. Temperatures fluctuating during transport and storage
6. Ethylene accumulation
7. Sub-optimal cultural practices or condition
8. Fungus and bacterial attack
9. Poor quality of water

The postharvest life of flowers is dependent on proper packaging and storage. Proper flower packaging coupled with pulsing insures fresh flower quality for consumers while potentially extending vase life.

Enclosing flower bunches in paper or cellophane and then placing them in corrugated fibre board cartons safeguards from physical damage, loss of water, and harmful external conditions.

Packaging material

Commonly used packing material for flowers are LDPE- Low Density Polyethylene, PO-Polyolefin, Butter paper, Butter paper, PP- Polypropylene, Cellophane, Newspaper, Banana leaves and other materials.

Packaging material qualities

Flower quality assurance, water loss reduction, physical injury protection, ease of use. The criteria of floral product packaging material qualities include making easy to handle during transportation of floral products. Material used for packing must be strong enough, moisture resistant, low price, reusable, and lastly compatible with packing line machinery. The choice of an appropriate packaging material is to achieve optimal passive carbon dioxide and oxygen levels is critical for flower storage (Patil and Singh, 2009) [2].

Storage

Flower storage is an essential component of post-harvest flower handling and management. It leads to more orderly marketing, lower retailer risks due to unexpected drops in demand, anticipating holidays, improved production efficiency, removal of greenhouse production in winters, energy savings, and long-term shipment. Storage methods include cold storage (wet and dry cold storage), controlled atmospheric storage (CAS), modified atmospheric storage (MAS), hypobaric storage (low pressure), and others.

A. Cold storage

Cold storage of flowers allows for the modification of flower and other planting material supplies to market mandate and the accumulation of large amounts of flowers. Low temperature treatment during storage and shipment decreases overall metabolism in the tissue and slows respiration. This is most common method of storage.

Flowers should be harvested when they are at their peak of development, pre-treated with a floral preservative, and pre-cooled for speedy packing. It is essential to keep the temperature constant and uniform. Temperate flowers such Rose, Carnation should be stored at 0-1° C, subtropical flowers i.e., gladiolus, jasmines, proteas, gloriosa are stored at 4-7° C, and tropical flowers such as Anthurium, Cattleya, Vanda, and Euphorbia store at at 7-15° C. Flowers can be stored in cold storage either dry storage or wet storage, based on the factors.

i) Wet storage

Flowers are stored in wet storage with their bases briefly dipped in a preservative solution or water. Flowers are kept at a temperature of 3-4° C, which is slightly higher than the temperature used for dry storage. To avoid wetting and subsequent decay, the lower-most leaves on the stems are removed. Fungi, bacteria, and yeast can infect vase water, causing plugging of cut stems. As a result, water disinfection with sodium hypochlorite should be done on a regular basis.

ii. Dry storage

For long-term storage, the dry storage method is used. To prevent moisture loss, flowers should harvest in early morning and then graded and packed in plastic sleeves/bags/boxes. Before storage, flowers can be pulsed with floral preservatives comprising sugar, antimicrobial, and anti-ethylene chemicals. Before placing items in polythene sacks or boxes, line them with a butter paper bag or newspaper. Wrapping flowers in soft paper will absorb any moisture that forms on the bloom.

Packing material and storage temperatures of flowers

Singh *et al.* (2009) [3] evaluated the impact of passive modified atmosphere packaging (MAP) on jasmine flower buds storage using polypropylene film (24µ) at different temperatures i.e., 2° C, 5° C, and 10° C. More freshness with less physiological loss in weight (PLW percent), longer shelf life, and no chilling injury in the form of browning and wilting in buds was found when buds are stored under passive MAP at 2° C and conclude that by using passive MAP with polypropylene film, buds of jasmine can be stored at 2° C in fresh stage with minimum PLW.

Adarsh Kumar *et al*. (2010) [4] studied the impact of various wrapping materials on the vase life of the tuberose cultivar 'Shringar,' noticed that spikes packed with polythene sheet and stored for 24 hours at 4 degrees Celsius resulted in increased diameter of flower (4.22 cm) and uptake of water (40.33 ml) during senescence.

Karuppaiah and Ramesh Kumar (2010) [5] conducted an experiment to standardise the thickness of polyethylene bag packaging and temperature during storage in order to increase the shelf life of tuberose and noticed that the cumulative physiological loss in weight and flower opening index were reduced in low temperature storage of the flowers with increased thickness in polyethylene bag. Moisture content, freshness index, and colour index increased as polyethylene bag thickness increased and storage temperature decreased. Tuberose had a shelf life of 82.20 hours in 300 gauge polyethylene bags stored at 5° C, and unpacked flowers stored at room temperature had a shelf life of 35.52 hours. The shelf life was increased by more than 200 percent.

Patil and Dhaduk (2010) [6] improved total vase life, total post-harvest life, and quality of tuberose Cv. Local Double was with treatment combination with 5° C dry cold storage temperature using polyethylene (100 gauge) packing with 4 days storage duration.

Sahare *et al.* (2011) [7] studied the impact of pre-storage pulsing and cold storage with different poly film packaging on flower quality of tuberose cut spikes and discovered that pre-storage pulsing with TDZ andα -lipoic acid, as well as storage with poly film packaging composed of HDPE, LDPE, and PP at 2° C temperature for 15 days, significantly influenced post storage quality and vase life of tuberose cut spikes.

Gerbera cut flowers stored at 6° C packed in PP packaging showed significantly negligible physiological weight loss, no scape bending after storage, high uptake of water, retained fresh weight with improved flower size during vase life with higher dry weight, membrane stability index (MSI), and total dissolved solutes (TDS), delayed petal senescence, and increased vase life (Joshi, 2012) [8]

Saidulu (2013) [9] revealed that marigold flowers packed in onion mesh bags and 3% ventilation polyethylene bags had the highest physiological loss of weight and the shortest storage life at both ambient (3.17 and 3.33 days) and cold storage at 10degrees Celsius (5.25 and 5.58 days).

Dastagiri *et al*. (2014) [10] investigated the keeping quality of

Ornithogalum under various packing materials under cold storage for a period of 3, 6, 9 and 12 days at 4^0 C and concluded that cut stems packed in cellophane and preserved showed the greatest water uptake with the fewest unopened florets. Cold storage of spikes covered in cellophane for three days preserved good keeping quality with improved floret opening, size, and aesthetic.

Meenu (2014) [11] investigated the effect of different packaging materials, namely LDPE (100 µ), LDPE (200 µ), polypropylene (PP), polyethylene (PE), micro perforated film (MP), and cellophane, as well as a control, on the keeping quality of cut chrysanthemum flowers. As compared to the control, there is a reduction in floret and leaf senescence and an increase in fresh weight of packed flower with LDPE (200 µ), followed by LDPE (100 µ).

Warinthon and Peeyus (2014) [12] studied the impact of modified atmosphere packaging (MAP) treatment using various packing materials on the storability and quality of cut dendrobium orchids which are stored at 13 °C with 95 percent RH. Longest storage life of dendrobium orchids i.e., 18 days was observed when packed with Polypropylene (PP) film with lowest weight loss, ethylene production, respiration rates, and anthocyanin content when compared to control.

The impact of wrapping material and storage conditions on chrysanthemum postharvest life was investigated by Srivastava *et al*. (2015) [13], and it was found that wrapping the flowers in PP 200 gauge with refrigerated storage at 3-4° C for 3 days + 6 hours of simulated transportation resulted in less percent weight loss, maximum total water absorbed, flower diameter, and vase life.

Patel *et al*. (2016) [14] investigated the effect of various packaging films (PP (24µ), HDPE (28µ), LDPE (112µ), and control (no packaging) and storage temperatures (5° C, 10° C, and 15° C) on gerbera cut flowers over a 7-day period. When compared to all other treatments, PP packaged gerbera flowers stored at 5^o C showed significantly less physiological loss in weight just after storage, maximum water uptake (119.33 ml), and higher retention of fresh weight during vase life after storage.

Subhra *et al*. (2017) [15] investigated the impact of pre-cooling and different packaging methods of loose tuberose cv. Prajwa and stated that flowers pre-cooled and kept in Corrugated Fibre Board (CFB) box with 100 gauge at 4° C outperformed all other treatment combinations, with a shelf life of 15 days.

Archana *et al.* (2019) [16] investigated the impact of various packaging materials i.e., PP-Polypropylene bags and LDPE bags at various thicknesses of 100 and 200 guage and storage conditions i.e., ambient conditions, 4° C and 6° C on the keeping quality of tuberose loose flowers cv. Bidhan Rajini-1. According to the study, loose flowers packaged in 200 gauge LDPE bags and stored at 4o C had the least PLW (0.656 percent), the highest relative water content (86.15 percent), and the longest days for fifty percent wilting (17.6 days), and the freshness of flowers remained for period of 21 days.

Ankush *et al.* (2019) conducted research on the physical properties and shelf life of Rose and Plumeria flowers using various packing materials and temperature conditions and concluded Flowers packed in polythene pouches at room temperature lost the least amount of weight, followed by flowers kept in refrigerated conditions without any covering. The smallest size reduction was observed in polythene bag packed flowers maintained in the refrigerator, next by aluminium foil packed flowers held at room temperature.

Panwar Sapna *et al*. (2020) [17] carried out an experiment to standardise the packing materials and storage conditions in order to extend the shelf life of loose African marigold flowers variety Pusa Narangi Gainda, and determined that the best treatment for extending the shelf life of loose flowers of the African marigold variety Pusa Narangi Gainda was to packing the flowers in polythene bags (200 gauge) and storing them at 6 °C.

Prashant *et al*. (2021) [18] Researchers investigated several marigold packaging methods and storage conditions and concluded that flowers packaged in cardboard boxes lined with polyethylene had the greatest shelf life (4.13 days) with the best freshness index, maximum moisture content, least weight loss, and least deterioration.

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