**"Synergistic impact of packaging materials and varietal differences on the postharvest quality of chrysanthemum"**

**Abstract**

Floriculture in India has witnessed significant growth, with major production in states like Tamil Nadu, Karnataka and Madhya Pradesh. Chrysanthemum, a commonly cultivated flower, faces post-harvest challenges such as rapid senescence and reduced shelf life. The study was conducted at the Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru, during 2019-2021. The objective was to identify the most effective packaging material for extending the shelf life and preserving the postharvest quality of Chrysanthemum cut flowers. Seven different packaging treatments were tested: control (no packing), polythene film (100 µ), newspaper, plastic-coated brown paper, corrugated fibreboard (CFB), butter paper and nano silver-coated polyethylene. The experiment followed a Factorial Completely Randomized Design with two chrysanthemum varieties (NPF Yellow and Danty Purple) and two replications. The parameters measured were physiological loss in weight (PLW), freshness index, and shelf life. Results indicated that the variety NPF Yellow exhibited higher freshness scores (5.12) and shelf life (2.90 days) compared to Danty Purple (4.86 and 2.52 days, respectively). Among the packaging treatments, nano silver-coated polyethylene (P₇) demonstrated the best performance, with the highest freshness score (7.78) and shelf life (4.44 days). The combination of NPF Yellow with nano silver-coated polyethylene (V₁P₇) produced the most favorable results, achieving the longest shelf life (4.81 days). The control treatment recorded the lowest freshness and shelf life. The study emphasizes the importance of both genetic factors and advanced packaging materials in maintaining the freshness and extending the shelf life of cut chrysanthemums, particularly when combined with antimicrobial, atmosphere-modifying packaging like nano silver-coated polyethylene.

Keywords ??

**Introduction**

 Floriculture in India has been rapidly growing, with an area of 2.83 lakh hectares dedicated to flower cultivation in 2022–2023, producing 2.30 million tonnes of loose flowers and 0.83 million tonnes of cut flowers. Major flower-producing states include Tamil Nadu, Karnataka, and Madhya Pradesh. The country exported ₹707.81 crores worth of floriculture products in the same year. However, due to the perishable nature of flowers, frequent market gluts lead to price crashes and losses for farmers. Chrysanthemum, the third most cultivated flower in India, often faces postharvest challenges, which can be mitigated through effective packaging, preservatives, and cold storage. Packaging in polyfilms under refrigerated conditions reduces water loss, slows respiration, and prevents microbial growth, significantly extending the vase life of cut flowers. Postharvest management techniques can enhance the market value of flowers by 9–10 times, making them essential for managing glut periods and export viability. The study aims to standardize the best packaging and storage methods to improve the shelf life and quality of cut chrysanthemums.

**Review of literature**

Kumar *et al*. (2006) reported that cut chrysanthemum flowers packed in wax paper and stored in cold conditions for 24 hours showed maximum vase life (19.20 days), flower size (10.90 cm), solution uptake (259.30 ml), and sugar content (41.81 mg/g) with minimal weight loss (5.16%), whereas flowers wrapped in newspaper and stored at ambient conditions for 72 hours recorded the lowest results.

 Suresh *et al*. (2011) observed enhanced flower quality when flowers were packed in polyethylene and cold stored at 10°C, resulting in maximum flower diameter (5.94 cm), fresh weight (16.24 g), and minimal petal drop and physiological weight loss. Meenu *et al*. (2014) found that LDPE wrapping (200 µ and 100 µ) reduced floret and leaf senescence and increased fresh weight in *Chrysanthemum morifolium* cv. Reagon White.

Sharma and Srivastava (2014) demonstrated that wrapping cut chrysanthemum spikes with PP 200 gauge and storing them at 3–4°C preserved flower quality and extended vase life in cvs. Snowball Yellow and Snowball White.

Kumari *et al*. (2017) confirmed that LDPE 100 gauge packing maintained membrane stability and sugar content while reducing physiological weight loss.

Cheng *et al*. (2018) revealed that packaging garland chrysanthemums with PCL/PPC film and storing them at 2–4°C effectively prevented senescence and decay, extending shelf life up to 14 days.

 Preeti and Sushma (2022) concluded that LDPE-100 gauge wrapping resulted in the longest flower vase life (12.80 days) and leaf vase life (5.98 days), while PP 100 gauge minimized weight loss (13.72%) and maintained larger flower diameter (4.18 cm) post-transit.

**Material and methodology**

The study was conducted in March 2019- 2021 at the Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru. The objective was to identify the most suitable packaging material for extending the shelf life and maintaining the postharvest quality of chrysanthemum (*Dendranthema grandiflora* Tzvelve) cut flowers. Flowers were harvested at the commercial stage from a naturally ventilated polyhouse and immediately hydrated before treatment. Uniform flower stalks were trimmed and subjected to seven packaging treatments: no packing (control), polythene film (100 micron), newspaper, plastic-coated brown paper, corrugated fibreboard (CFB) wraps, butter paper and nano silver-coated polyethylene. The experiment followed a Factorial Completely Randomized Design with two varieties, two replications and was conducted under laboratory conditions (26–35°C, 60–75% RH). Physiological loss in weight (PLW) was calculated at daily intervals, while freshness index was visually scored using a 5-point scale based on petal colour retention and wilting symptoms. Shelf life was determined as the number of hours during which 50% or more flowers retained freshness. Data were statistically analyzed using Fisher’s method as per Panse and Sukhatme (1967), with significance tested at the 5% level. The study provided insights into the most effective packaging material that preserved the freshness and extended the shelf life of cut chrysanthemums under ambient storage conditions.

**Results**

**Table 1: Effect of different packing material on freshness index score of cut chrysanthemum cvs. NPF Yellow and Danty Pink**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** | **Year 1** | **Year 2** | **Pooled mean** |
| **Factor 1 (Variety)** |
| V1 | 5.27 | 4.98 | 5.12 |
| V2 | 5.05 | 4.66 | 4.86 |
| **SEm ±** | **0.05** | **0.06** | **0.05** |
| **CD @ 1 %** | **0.21** | **0.26** | **0.21** |
| **Factor 2 (Packaging material)** |
| P1 | 1.94 | 1.59 | 1.76 |
| P2 | 6.94 | 6.53 | 6.73 |
| P3 | 3.51 | 3.14 | 3.33 |
| P4 | 6.34 | 6.62 | 6.48 |
| P5 | 4.94 | 4.66 | 4.80 |
| P6 | 4.30 | 3.84 | 4.07 |
| P7 | 8.18 | 7.38 | 7.78 |
| **SEm ±** | **0.09** | **0.12** | **0.09** |
| **CD @ 1 %** | **0.39** | **0.49** | **0.39** |
| **Interaction (V × P )** |
| V1P1 | 2.20 | 2.10 | 2.15 |
| V1P2 | 6.20 | 5.70 | 5.95 |
| V1P3 | 3.90 | 3.18 | 3.54 |
| V1P4 | 6.55 | 7.16 | 6.86 |
| V1P5 | 5.25 | 5.06 | 5.16 |
| V1P6 | 4.35 | 4.06 | 4.20 |
| V1P7 | 8.45 | 7.60 | 8.02 |
| V2P1 | 1.68 | 1.08 | 1.38 |
| V2P2 | 7.68 | 7.36 | 7.52 |
| V2P3 | 3.13 | 3.11 | 3.12 |
| V2P4 | 6.13 | 6.08 | 6.10 |
| V2P5 | 4.63 | 4.25 | 4.44 |
| V2P6 | 4.25 | 3.63 | 3.94 |
| V2P7 | 7.90 | 7.16 | 7.53 |
| **SEm ±** | **0.13** | **0.16** | **0.13** |
| **CD @ 1 %** | **0.55** | **0.69** | **0.56** |

**Table 2: Effect of different packing material on shelf life (days) of cut chrysanthemum cvs. NPF Yellow and Danty Pink**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** | **Year 1** | **Year 2** | **Pooled data** |
| **Factor 1 (Variety)** |
| V1 | 2.97 | 2.84 | 2.90 |
| V2 | 2.61 | 2.43 | 2.52 |
| **SEm ±** | **0.03** | **0.04** | **0.03** |
| **CD @ 1 %** | **0.13** | **0.16** | **0.12** |
| **Factor 2 (Packaging material)** |
| P1 | 1.58 | 1.50 | 1.54 |
| P2 | 3.13 | 3.02 | 3.08 |
| P3 | 1.95 | 1.76 | 1.86 |
| P4 | 3.69 | 3.42 | 3.56 |
| P5 | 2.48 | 2.20 | 2.34 |
| P6 | 2.24 | 2.14 | 2.19 |
| P7 | 4.48 | 4.40 | 4.44 |
| **Sem ±** | **0.06** | **0.07** | **0.05** |
| **CD @ 1 %** | **0.24** | **0.30** | **0.22** |
| **Interaction (V × P)** |
| V1P1 | 1.93 | 1.90 | 1.91 |
| V1P2 | 3.30 | 3.18 | 3.24 |
| V1P3 | 2.11 | 1.90 | 2.00 |
| V1P4 | 3.78 | 3.58 | 3.68 |
| V1P5 | 2.55 | 2.40 | 2.48 |
| V1P6 | 2.30 | 2.12 | 2.21 |
| V1P7 | 4.83 | 4.80 | 4.81 |
| V2P1 | 1.23 | 1.10 | 1.16 |
| V2P2 | 2.97 | 2.87 | 2.92 |
| V2P3 | 1.80 | 1.63 | 1.71 |
| V2P4 | 3.61 | 3.27 | 3.44 |
| V2P5 | 2.40 | 2.01 | 2.20 |
| V2P6 | 2.17 | 2.17 | 2.17 |
| V2P7 | 4.13 | 4.00 | 4.06 |
| **SEm ±** | **0.08** | **0.10** | **0.07** |
| **CD @ 1 %** | **0.34** | **0.42** | **0.31** |

Significant differences were observed in freshness index scores among varieties, packaging materials and their interactions over the two-year study (2019–2021). Among the varieties, NPF Yellow (V₁) consistently exhibited the highest freshness index score (5.27 in the first year and 4.98 in the second year), while Danty Purple (V₂) recorded the lowest (5.05 and 4.66, respectively). The pooled mean confirmed V₁ (5.12) as superior to V₂ (4.86). Packaging material significantly influenced freshness scores. Treatment P₇ (Nano silver-coated polyethylene film) resulted in the highest scores (8.18 and 7.38), followed by P₂ (100-micron polythene film wrapping) with scores of 6.94 and 6.53. The control (P₁) recorded the lowest scores (1.94 and 1.59). The pooled mean showed maximum freshness in P₇ (7.78) and minimum in P₁ (1.76). The interaction effect between variety and packaging was significant. The combination V₁P₇ consistently recorded the highest freshness index (8.45 and 7.60), while V₂P₁ recorded the lowest (1.68 and 1.08). The pooled interaction means further confirmed V₁P₇ (8.02) as the best and V₂P₁ (1.38) as the least effective. Varietal differences in shelf life were also found significant. NPF Yellow (V₁) recorded a longest shelf life (2.97 and 2.84 days), compared to Danty Purple (V₂) (2.61 and 2.43 days), with a pooled mean of 2.90 and 2.52 days for V₁ and V₂, respectively. Among packaging treatments, P₇ (Nano silver-coated polyethylene film) exhibited the longest shelf life (4.48 and 4.40 days), followed by P₂ (3.13 and 3.02 days). The control (P₁) recorded the shortest shelf life (1.58 and 1.50 days). The pooled mean showed maximum shelf life in P₇ (4.44 days) and minimum in P₁ (1.54 days). The interaction effect was statistically significant, with V₁P₇ recording the highest shelf life (4.83 and 4.80 days), and V₂P₁ recorded the lowest (1.23 and 1.10 days). Pooled mean values confirmed V₁P₇ (4.81 days) as the most effective combination and V₂P₁ (1.16 days) as the least.

**Discussion**

Sensory evaluation of cut chrysanthemum, measured using a 9-point hedonic scale, revealed significant differences in freshness index score and shelf life across varieties, packaging materials, and their interactions. The variety NPF Yellow consistently recorded the highest freshness index score and shelf life, which may be attributed to its favorable genetic traits and greater uptake of moisture. Among the packaging treatments, nano silver-coated polyethylene film proved most effective, with the highest mean freshness index and shelf life values. This can be linked to the film’s capacity to create a modified atmosphere and its antimicrobial properties, which reduce microbial growth and preserve flower quality. The interaction of NPF Yellow with nano silver packaging (V1P7) yielded the best results in both parameters, highlighting a synergistic effect between varietal characteristics and advanced packaging technology. These findings suggest that combining responsive varieties with antimicrobial and atmosphere-modifying packaging significantly enhances postharvest performance in cut chrysanthemums.

The discussion should be strengthened by giving reasons for the results by aligning with the results of previous studies related to this study.

**Summary and Conclusion**

The pooled mean data across two seasons revealed significant effects of variety and packaging material on the freshness score index and shelf life of flower stalks. Among the varieties, NPF Yellow (V₁) consistently exhibited superior performance with a maximum freshness score index of 5.12 and shelf life of 2.90 days, while Danty Purple (V₂) recorded lower values (4.86 and 2.52 days, respectively), indicating varietal influence on postharvest quality. Regarding packaging materials, Nano silver-coated polyethylene (P₇) was the most effective, showing the highest freshness score index (7.78) and shelf life (4.44 days), whereas the control (P₁) recorded the lowest values (1.76 and 1.54 days, respectively). The interaction effects were significant, with the combination V₁P₇ showing the maximum freshness index (8.02), and V₁P₄ achieving the longest shelf life (4.81 days). Conversely, the least performance was observed in the V₂P₁ treatment (freshness index 1.38 and shelf life 1.16 days). These findings highlight the synergistic benefits of using genetically superior varieties with advanced packaging materials, particularly nano silver-coated polyethylene, to effectively maintain flower freshness and prolong shelf life during storage and handling.

Conclusions should be written rather than writing results and discussions,

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