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# EFFECT OF PACKAGING MATERIAL AND STORAGE ON CERTAIN POSTHARVEST ATTRIBUTES IN LOOSE FLOWER OF TUBEROSE *(POLIANTHES TUBEROSA)* CULTIVAR ARKA PRAJAL

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**ABSTRACT**

Tuberose *(Polianthes tuberosa* Linn.) which is known as *Rajanigandha* in Hindi is an important commercial loose flower crop because of its fragrant white flowers which can be utilized in many ways. Tuberose loose flowers retain their freshness only for one to two days under ordinary condition. Packaging technology concentrated on longer period of storage of loose flowers, would certainly be benefited. In view of rapidly increasing demand of loose flowers of tuberose and need for extending the postharvest quality, the present investigation was carried out in order to study the response of packaging materials *viz.* woven bag, high density polyethylene (HDPE) 51 micron thickness bag, low density polyethylene (LDPF) 25 micron thickness bag, muslin cloth bag and bamboo basket (control, without packaging) and two storage conditions *i.e.*, ambient condition (22 ±1°C temp.) and cold storage (or low temperature) condition (5 ± 1°C temp.) and 85-95% relative humidity) on certain self-life quality attributes of loose flowers of Single petalled tuberose cv. Arka Prajwal. Fully developed unopened florets (loose flowers) were harvested in the early morning hours from growing spikes. It was observed that packaging and storage condition significantly influenced all studied parameters. Among all treatments, loose flowers packed in HDPE 51-micron thickness bag and stored under cold storage condition recorded the maximum flower diameter (8.99 mm), flower opening index (77.85%), colour (whiteness) index (89.13%) and shelf life (6.00 day). In control treatment the above parameters recorded were 6.98 mm, 50.00%, 54.10% and 3.50 day, respectively. Under ambient condition, the maximum flower diameter (8.08 mm), flower opening index (66.00%), colour index (91.85%) and shelf life (4.00 day) of loose flowers were recorded with HDPE 51-micron thickness bag packaging. In control treatment the above said parameters were recorded 6.73 mm, 50.00%, 63.77% and 1.50 day, respectively.

***Key words*: Flower diameter, flower opening index, flower color index, high density polyethylene, loose flower, *Polianthes tuberosa*, tuberose.

## Introduction

Flowers are one of the most amazing creations on the earth and have been associated with human's due to their beauty, color, form, texture, nobility and fragrance. Due to gradual increase in demand for flowers, they have become an important commercial trade in agriculture. Floriculture sector is generating high income, employment opportunities in its various trades and enhancement of export. Tuberose **(***Polianthes tuberosa* Linn.**)** which is known as *Rajanigandha* in Hindi, belongs to the family Agavaceae and originated in Mexico. Tuberose can be used as loose flower, cut flower, landscaping or bedding purpose, extraction of essential oils for perfume industry, nutraceutical, etc. (Singh *et al.*, 2010). It is an important herbaceous perennial bulbous flowering plant and is being cultivated in most parts of sub-tropical and tropical countries of the world including India. Based on the number of rows of corolla segment it is classified as Single petalled, Semi-double petalled and double petalled types. For loose flowers utilization its Single petalled type cultivars are preferred over Double petalled cultivars. For loose flower utilization its Single petalled type cultivars are preferred over Double petalled cultivars. The major portion of tuberose flowers consumption is in the various forms of loose flowers, followed by cut flowers and extraction of essential oils (Singh *et al.*, 2010). In India, the area under tuberose cultivation is about 16.19 thousand hectares with a production of 107.91 thousand metric ton of loose flowers and 89.29 thousand metric ton of cut flowers. In India, four main tuberose growing states are-West Bengal, Tamil Nadu, Andhra Pradesh and Karnataka.

The prices of tuberose loose flowers are determined by market demand, quantity of production and their freshness. Production of high-quality flowers is important in fetching up higher prices in market. Tuberose loose flowers are delicate and perishable in nature, hence it is necessary step to handle the flowers properly after harvesting them from plants. Tuberosa loose flowers retain their freshness only for one or two days under ordinary condition, thus bring down their market value and limit their transport to long distance market, consequently leading to huge wastage of this valuable bio-resource (Singh *et al.*, 2022).

Flowers weight and their freshness play a very important role in fetching the higher prices in loose flower market. Marketing of flowers without proper postharvest handing leads to reduction in quality (freshness) as well as its quantity (fresh weight) due to damage caused by various factors which reduces the shelf life, storability and deprives the stake holders in getting the better price of their produce. Postharvest technologies like packaging and storage of flowers are helpful to restrict the changes in metabolic activities. Packaging is a technique of protecting the flowers from the physical damage, water loss and external conditions during transport and enhance the shelf life of flowers (Patil and Dharuk, 2010; Majumdar *et al.*, 2014). However, very little results are documented to prolong the storability of loose flowers in tuberose. Keeping these considerations in point of view, the present study was undertaken with an objective to find out the suitable packaging material and storage condition for enhancing diameter, opening index, color index and shelf life of loose flowers of Single petalled tuberose cv. Arka Prajwal.

## Materials and Methods

The present investigation was conducted at the Division of Floriculture and Landscaping, ICAR-Indian Agricultural Research Institute, New Delhi during 2020-2021. The unopened mature florets of Single petalled tuberose cv. Arka Prajwal were harvested during early morning hours. The experiment was conducted with five packaging materials and two storage conditions namely, $P_1$-Woven bag, $P_2$-High density polyethylene, (HDPE) 51-micron (μ) thickness bag, $P_3$-Low density polyethylene (LDPE) 25-micron (μ) thickness bag, $P_4$-Muslin cloth bag and $P_5$-Bamboo basket (control) and two storage conditions -$S_1$-Ambient condition (22 temp.) and $S_2$-Cold storage condition (or low temperature) condition -(with $5\pm1^oC$ temp. and 85-95% relative humidity). Mature unopened florets weighing a quantam of two kilograms for each treatment were taken. Periodical observations on flower diameter (mm), flower opening index (%), colour (whiteness) index and shelf life (day) were recorded. The flower diameter (mm) was measured with ten flowers at widest part by using Digital Vernier Callipers and then averaged. For recording the flower opening index (%) on each day of observation, the number of opened flowers (whether fresh or wilted) were recorded and expressed as percentage. Flower colour index (whiteness) is one of the most important attributes that reflect tuberose flower quality and freshness. Colour change or fading can affect the flower quality and acceptability, rapid senescence of flower causes of yellowing and browning. Flower colour was measured using portable colorimeter. The colorimeter was calibrated with a white standard calibration plate before measurement and the direct reading was noted down from the instrument screen. The colour (whiteness index, WI) used as an indicator of intensity of white colour was calculated by using numerical values of L*, a* and b*. As per the commission on Illumination (CIE) L* a* b* system of colour representation, the L value corresponds to a dark - bright scale and represents the relative hue (colour). The a* and b* values extend from -60 to 60; a negative is for green a* positive is for red and b* negative is for blue and positive of yellow.

Whiteness index was calculated by using the following formula: Whiteness index (WI)=100-[(100-L*) + ($a^{*2}$ + $b^{*2}$) 1/2. The shelf life of flowers was determined as number of days taken from placing the mature flower buds till wilting/fading of petals and time taken for development of necrotic symptoms was recorded. The statistical design of experiment was followed factorial completely randomized design (FCRD) in which packaging materials and storage conditions were two factors and all treatments were replicated four times. Recorded data were subjected to statistical analyses. Computation of mean, standard error mean (SE) and critical difference (C.D) was used for all comparisons where significance of F- probability ($P = \leq 0.5$) were found using OPSAT version 6.1 software for analysis of variance (ANOVA).

**Table 1:** Effect of packaging material, duration and their interaction on floret diameter (mm) of tuberose cv. Arka Prajwal loose flowers under ambient and cold storage condition.

| Packaging material (P) | Storage condition | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ambient storage | | | | | | Cold storage | | | | | | | | |
| | Duration (D) | | | | | | Duration (D) | | | | | | | | |
| | 0 | 1 | 2 | 3 | 4 | Mean | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Mean |
| **$P_1$:** Woven bag | 6.28 | 7.55 | 7.99 | 8.05 | 8.28 | 7.63 | 6.38 | 7.33 | 7.67 | 8.43 | 9.04 | 9.27 | 9.50 | 8.23 |
| **$P_2$:** HDPE 51 micron bag | 6.79 | 7.82 | 8.43 | 8.56 | 8.83 | 8.08 | 6.66 | 7.55 | 8.17 | 9.33 | 9.91 | 10.49 | 10.82 | 8.99 |
| **$P_3$:** LDPE 25micron bag | 6.45 | 7.64 | 8.11 | 8.28 | 8.47 | 7.79 | 6.53 | 7.10 | 7.92 | 8.71 | 9.33 | 9.60 | 9.82 | 8.43 |
| **$P_4$:** Muslin cloth bag | 6.20 | 6.83 | 7.76 | 7.50 | 7.32 | 7.12 | 5.71 | 6.05 | 7.29 | 8.28 | 8.55 | 8.16 | 8.06 | 7.44 |
| **$P_5$:** Control (bamboo basket) | 5.23 | 6.49 | 7.53 | 7.27 | 7.12 | 6.73 | 5.39 | 6.63 | 7.07 | 7.89 | 7.49 | 7.28 | 7.14 | 6.98 |
| **Mean** | 6.19 | 7.26 | 7.96 | 7.93 | 8.00 | – | 6.13 | 6.93 | 7.62 | 8.53 | 8.86 | 8.96 | 9.07 | – |
| | **C.D.$_{(P=0.05)}$** | | | | | | **C.D.$_{(P=0.05)}$** | | | | | | | |
| **Packaging material (P)** | 0.10 | | | | | | 0.13 | | | | | | | |
| **Duration (D)** | 0.10 | | | | | | 0.16 | | | | | | | |
| **Interaction (PXD)** | 0.24 | | | | | | 0.35 | | | | | | | |

## Results and Discussion

### Flower diameter (mm)

It is clear from Table 1 that under ambient condition, there was a significant difference among the packaging material, duration and their interaction on diameter of flower. Among five packaging materials tested, flowers packed in HDPE 51-micron thickness bag recorded the maximum floret diameter (8.08 mm) which was statistically higher with other treatments of packaging materials, whereas the minimum floret diameter (6.73 mm) was recorded in control treatment (bamboo basket). The maximum floret diameter (8.00 mm) was recorded on fourth day which was statistically higher with other days, while the minimum floret diameter (6.19 mm) was recorded on zero day *i.e.* on initial day. The interaction effect of packaging material and duration indicates that the maximum floret diameter (8.83 mm) was recorded in loose flowers packed in HDPE 51-micron thickness bag on fourth day, while the minimum floret diameter (5.30 mm) was recorded in control treatment on zero day.

Table 1 also indicates that under cold storage condition, there was a significant difference among packaging material, duration and their interaction. Tuberose loose flowers packed in HDPF 51-micron thickness bag recorded the maximum flower diameter (8.99 mm) which was higher with other packaging materials, whereas the minimum flower diameter (6.98 mm) was observed under control treatment. The maximum floret diameter (9.07 mm) was recorded on sixth day, which was higher with other days and *at par* with fifth day, while the minimum flower diameter (6.13 mm) was observed on zero day. The interaction effect of packaging material and duration indicates that the maximum flower diameter (10.82 mm) was recorded in flowers packed in HDPE 51-micron thickness bag on sixth day, which was statistically *at par* with $P_2$ treatment on fifth day, while the minimum floret diameter (5.39 mm) was recorded on zero day, which was statistically *at par* with $P_4$ treatment (muslin cloth bag).

Loose flowers of tuberose packed in HDPE 51-micron thickness bag recorded the maximum flower diameter and minimum flower diameter under control treatment (bamboo basket). This might be due to modified atmosphere condition of high carbon dioxide, high relative humidity and low oxygen concentration within a package result in low respiration (Farber *et al.*, 2003) and helps in minimization of loss of carbohydrates as well as water by a process of respiration and transpiration, respectively (Zeltzer *et al.*, 2001) from the petal cells and increase floret opening results in increased floret diameter. Reduced floret diameter in control treatment was due to the inhibition of corolla growth and flower opening as a result of low water potential and low carbohydrates states in the petal cells (Vandroom *et al.*, 1991). Our findings are in close agreements with the results obtained by Khongwir *et al.*, (2017) in Single petalled tuberose cultivars.

### Flower opening index (%)

As evident from Table 2 that under ambient condition, there was a significant difference among the packaging material, duration and non-significant difference on their interaction on floret opening of tuberose cv. Arka Prajwal. Among packaging materials, loose flowers packed in HDPE 51-micron thickness bag recorded the maximum floret opening (66.00%) which was higher with other packaging materials, whereas the minimum flower opening (38.00%) was recorded under control treatment flowers. The maximum flower opening (72.00%) was

**Table 2:** Effect of packaging material, duration and their interaction on flower opening (%) of tuberose cv. Arka Prajwal loose flowers under ambient and cold storage condition.

| Packaging material (P) | Storage condition | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ambient storage | | | | | | Cold storage | | | | | | | |
| | Duration (D) | | | | | | Duration (D) | | | | | | | |
| | 0 | 1 | 2 | 3 | 4 | Mean | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Mean |
| $P_1$: Woven bag | 20.00 | 50.00 | 60.00 | 75.00 | 75.00 | 56.00 | 25.00 | 55.00 | 65.00 | 75.00 | 75.00 | 80.00 | 80.00 | 65.00 |
| $P_2$: HDPE 51 micron bag | 30.00 | 60.00 | 70.00 | 85.00 | 85.00 | 66.00 | 30.00 | 70.00 | 80.00 | 85.00 | 90.00 | 95.00 | 95.00 | 77.85 |
| $P_3$: LDPE 25micron bag | 25.00 | 55.00 | 65.00 | 80.00 | 80.00 | 61.00 | 30.00 | 60.00 | 70.00 | 80.00 | 80.00 | 85.00 | 85.00 | 70.00 |
| $P_4$: Muslin cloth bag | 15.00 | 40.00 | 55.00 | 70.00 | 70.00 | 50.00 | 20.00 | 50.00 | 60.00 | 65.00 | 65.00 | 70.00 | 70.00 | 57.14 |
| $P_5$: Control (bamboo basket) | 10.00 | 30.00 | 50.00 | 50.00 | 50.00 | 38.00 | 10.00 | 45.00 | 55.00 | 60.00 | 60.00 | 60.00 | 60.00 | 50.00 |
| **Mean** | 20.00 | 47.00 | 60.00 | 72.00 | 72.00 | – | 23.00 | 56.00 | 66.00 | 73.00 | 74.00 | 78.00 | 78.00 | – |
| | **C.D.$_{(P=0.05)}$** | | | | | | **C.D.$_{(P=0.05)}$** | | | | | | | |
| **Packaging material (P)** | 3.93 | | | | | | 3.44 | | | | | | | |
| **Duration (D)** | 3.93 | | | | | | 4.07 | | | | | | | |
| **Interaction (PXD)** | N.S. | | | | | | N.S. | | | | | | | |
| **N.S.= non-significant** | | | | | | | | | | | | | | |

recorded on third and fourth day, which was higher with other days, while the minimum flower opening (20.00%) was recorded on zero day *i.e.*, on first day.

Table 2 also indicates that under cold storage condition there was a significant difference among packaging material, duration and non-significant difference on their interaction. Flowers packed in HDPE 51-micron thickness bag observed the maximum floret opening (77.85%) which was statistically higher with other packaging materials, whereas the minimum floret opening (50.00%) was recorded in control treatment. The maximum flower opening (78.00%) was recorded on fifth and sixth day, which was statistically higher with other days, while the minimum flower opening (23.00%) was recorded on zero day. In our study, loose flowers packed in HDPE recorded the maximum flower opening index. Flower opening associated with change in petal orientation. Osmotic changes in special cells, at petal base results in opening and closing movements in flowers. Metabolic activity in flowers is regulated by modified atmosphere condition created within the package (Goszezynska and Rudnicki, 1988) and maintenance of relative humidity may influence flower opening. Gladiolus spikes dry stored in polyethylene sleeves indicated considerable decline in post storage vase life and opening of florets, with an increase in storage duration (Jhangi and Dhatt, 2017). Similar trend was observed in our study also where flower opening declined towards the end of storage duration. This might be due to decline in stored food and water status in the petal cells with the advancement of storage duration (Khongwir *et al.*, 2017).

**Flower color index (whiteness index)**

Table 3 reveals that under ambient condition, significant difference among packaging material, duration and their interaction was observed on color index of loose flowers of tuberose. Among five packaging materials, flowers packed in HDPE 51-micron thickness bag recorded the maximum white color (91.85) which was statistically better with other packaging materials; whereas the minimum white colour (79.19) was recorded in control treatment flowers. The maximum white colour (99.19) was recorded on zero day, which was statistically superior with other days, while the minimum mean of white colour (72.79) was recorded on fourth day. Interaction effect of packaging material and duration shows that the maximum white colour (99.82) was recorded in flowers packed in HDPE 51-micron thickness bag on zero day, while the minimum white colour (63.77) was recorded in control treatment flowers on sixth day.

Table 3 also reveals that under cold storage condition, there was a significant difference among packaging material, duration and their interaction. Flowers packed in HDPE 51-micron thickness bag recorded the maximum white colour (89.13) which was statistically higher with other packaging materials, whereas the minimum white colour (77.79) was recorded in control treatment. The maximum white colour (99.32) was recorded on zero day which was statistically superior with remaining days, while the minimum mean of white colour (65.70) was recorded on sixth day. Interaction response of packaging material and duration indicates that the maximum white colour (99.95) was recorded in flowers packed in HDPE 51-micron thickness bag on zero day, while the minimum white colour (54.10) was recorded in control treatment on sixth day.

In the present study, flowers packed in HDPE 51-

**Table 3:** Effect of packaging material, duration and their interaction on flower colour index (whiteness index) of tuberose cv. Arka Prajwal loose flowers under ambient and cold storage conditions.

| Packaging material (P) | Storage condition | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ambient storage | | | | | | Cold storage | | | | | | | |
| | Duration (D) | | | | | | Duration (D) | | | | | | | |
| | 0 | 1 | 2 | 3 | 4 | Mean | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Mean |
| $P_1$: Woven bag | 99.61 | 95.65 | 89.14 | 80.13 | 72.48 | 87.40 | 99.72 | 97.44 | 95.70 | 82.59 | 81.20 | 75.70 | 68.93 | 85.90 |
| $P_2$: HDPE 51 micron bag | 99.82 | 98.71 | 94.98 | 86.24 | 79.54 | 91.85 | 99.95 | 99.00 | 98.98 | 89.60 | 84.29 | 77.78 | 74.33 | 89.13 |
| $P_3$: LDPE 25micron bag | 99.73 | 96.66 | 92.94 | 83.83 | 77.69 | 90.17 | 99.85 | 98.00 | 97.83 | 86.32 | 82.99 | 76.61 | 72.09 | 87.67 |
| $P_4$: Muslin cloth bag | 98.82 | 93.42 | 84.70 | 74.38 | 70.48 | 84.36 | 98.97 | 96.49 | 95.44 | 78.49 | 75.94 | 64.77 | 59.04 | 81.30 |
| $P_5$: Control (bamboo basket) | 97.99 | 89.87 | 74.81 | 69.55 | 63.77 | 79.19 | 98.11 | 94.66 | 93.65 | 74.78 | 67.80 | 61.44 | 54.10 | 77.79 |
| **Mean** | 99.19 | 94.86 | 87.31 | 78.82 | 72.79 | – | 99.32 | 97.12 | 96.32 | 82.36 | 78.44 | 71.26 | 65.70 | – |
| | C.D.$_{(P=0.05)}$ | | | | | | C.D.$_{(P=0.05)}$ | | | | | | | |
| **Packaging material (P)** | 0.96 | | | | | | 0.67 | | | | | | | |
| **Duration (D)** | 0.96 | | | | | | 0.80 | | | | | | | |
| **Interaction (PXD)** | 2.15 | | | | | | 1.79 | | | | | | | |

micron thickness bag recorded the maximum white colour retention on zero day under ambient (99.19) and cold storage (99.95) condition and the minimum white colour under ambient (63.77) and cold storage (54.10) conditions on sixth day. It might be due to cellular senescence process of loose flowers which proceeded even during cold storage and such senescence activities were carried out at the expense of stored food in flowers. Although, at low temperature it was possible to store the flowers for longer period, the white colour was reduced as compared to shorter period (Happy *et al.,* 2022). Higher relative humidity and lower temperature might have favoured whiter colour in tuberose (Bhuvanesari and Sangama, 2017). Our results are also in close conformity with the findings of Sharma *et al.,* (2021) in marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda and Choudhary *et al.,* (2019) in jasmine (*Jasminum sambac*) cv. Gundumalli loose flowers.

### Shelf life (day)

As evident from Table 4 that under ambient condition there was a significant difference among different packaging materials on shelf life of tuberose loose flowers. Among five packaging materials tested, flowers packed in HDPE 51-micron thickness bag recorded maximum shelf life (4.00 day) which was statistically higher with other packaging materials and *at par* with $P_3$ treatment (LDPE 25 micron) whereas the minimum shelf life (1.5 day) was observed in control treatment (bamboo basket). Under cold storage condition, there was a significant difference among packaging materials on shelf life of flowers. Flowers packed in HDPE 51-micron thickness bag recorded maximum shelf life (6.00 day) which was statistically higher with other packaging materials and the minimum shelf life (3.50 day) was recorded in control treatment (bamboo basket). The maximum shelf life of flowers packed in polyethylene bag may be due to the reason that polyethylene sheet provides modified atmosphere, which increased carbon dioxide concentration as well as relative humidity and slowed down the respiration process (Hardenburg, 1971). Furthermore, it might have more amount of carbohydrates and energy because of permeability of polyethylene sheet which may lead to increase in shelf life of loose flowers. Our results are in close conformity with the results of Varu and Barad (2008); Majumdar *et al.,* (2014) in tuberose and Sharma *et al.,* (2021) in marigold flowers.

From the present investigation, it may be concluded that high density polyethylene (HDPE) 51-micron thickness bag was found to be the best packaging material for packaging of loose flowers of tuberose cv. Arka Prajwal under both ambient and cold storage conditions.

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**Table 4:** Influence of packaging materials on shelf life (day) of tuberose cv. Arka Prajwal loose flowers under ambient and cold storage condition.

| Packaging material (P) | Storage condition | |
|---|---|---|
| | Ambient | Cold storage |
| $P_1$: Woven bag | 3.50 | 5.12 |
| $P_2$: HDPE 51 micron bag | 4.00 | 6.00 |
| $P_3$: LDPE 25 micron bag | 3.87 | 5.50 |
| $P_4$: Muslin cloth bag | 3.00 | 4.50 |
| $P_5$: Control (bamboo basket) | 1.50 | 3.50 |
| C.D.$_{(P=0.05)}$ | 0.21 | 0.21 |

providing required facilities for carrying out the research work.

## References

Bhuvaneswari, S. and Sangama (2017). Eco-friendly packages for freshness retention and shelf-life extension of tuberose. *Journal of Horticultural Sciences*, **12(2)**, 198-200.

Choudhary, S., Das J.N., Mohanty C.R., Das A.K. and Mishra A.K. (2019). Packaging technology for extending shelf life of jasmine (*Jasminum sambac* cv. Gundumulli) flowers. *International Journal of Current Microbiology and Applied Sciences*, **8**(9), 1724-1732.

Farber, J.N., Harris L.J., Parish M.E., Beuchat L.R., Suslow T.V., Gorney J.R., Garrett E.H. and Busta F.F. (2003). Microbiological safety of controlled and modified atmosphere packaging of fresh and fresh cut produce. *Comprehensive Review in Food Science and Food Safety*, **2**, 142-160.

Gaszezynska, D.M. and Rudnicki R.M. (1988). Storage of cut flowers. *Horticulture Review*, **10**, 35-62.

Happy, Chahal, D., Devi S., Malik A. and Kumar A. (2022). Effect of wrapping materials and storage time on shelf life of tuberose (*Polianthes tuberosa* L.). *Agricultural Science Dijest*, **42(2)**, 137-144.

Hardenburg, R.E. (1971). Effect of package environment on keeping quality of fruits and vegetables. *Hort Science*, **6**, 198-201.

Jhangi, S. and Dhatt K.K. (2017). Effect of modified atmosphere packaging and storage duration on keeping quality of gladiolus spikes. *Indian Journal of Horticulture*, **74(4)**, 596-602.

Khongwir, N.K.L., Singh M.C., Singh K.P. and Arora A. (2017). Influence of different polyethylene packaging on shelf life of tuberose *(Polianthes tuberosa* Linn.*). Progressive Horticulture*, **49(2)**, 181-187.

Kumar, S., Kumar H., Vidhya Shankar M. and Kumar A. (2018). Studies on vase life of different cultivars of tuberose (*Polianthes tuberosa* Linn.). *International Journal of Chemical Studies*, **6(5)**, 2015-2019.

Majumdar, J., Singh K.P., Sellam P., Singh B. and Rai P. (2014). Effect of various chemicals with packaging and storage on tuberose. *Hort Flora Research Spectrum*, **3(2)**, 138-141.

Patil, S.D. and Dhaduk B.K. (2010). Efficasy of vrious wrappings for packaging along with storage temperature and duration on vase life of cut tuberose (*Polianthes tuberosa* L.) cv. Local Double. *Progresive Horticulture*, **42(2)**, 143-147.

Sharma, P., Kashyap B. and Pangtu S. (2021). Studies on storage and packaging of marigold flowers. *Journal of Pharmacognosy and Photochemistry*, **10(2)**, 32-37.

Singh, K.P., Kadam G.B. and Jyothi R. (2010). *Production Manual on Tuberose (Polianthes tuberosa* Linn.). DFR Extension Bulletin No. 1. Published by ICAR-Directorate of Floricultural Research, IARI Campus, New Delhi - 110012, 1-24.

Singh, K.P., Priya B.B., Jain R., Sethi S. and Lekshmy S. (2022). Enhaning shelf life of loose flowers of tuberose (*Polianthes tuberosa* Linn.) using preservatives and packaging materials. *Annals of Horticulture*, **15(2)**, 210-216.

Van Doorn, W.G., Groenewegen G., Van de Pol P.A. and Berkholst C.E.M. (1991). Effects of carbohydrate and water status on flower opening of cut Madelon roses. *Postharvest Biology and Technology*, **1(1)**, 47-51.

Varu, D.K. and Barad A.V. (2008). Effect of different packaging methods on vase life and quality of cut flowers in tuberose *(Polianthes tuberosa* L.) cv. Double. *Asian Journal of Biological Sciences*, **3**, 159-162.

Zeltzer, S., Meir S. and Mayank S. (2001). Modified atmosphere packaging of long-term shipment of cut flowers. *Acta Horticulturae*, **553**, 631-634.