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ASSESSMENT OF PACKAGING MATERIALS FOR MAINTAINING PHYSICAL QUALITY AND EXTENDING SHELF LIFE OF LOOSE TUBEROSE FLOWERS (*Agave amica*)

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ABSTRACT

The present study, entitled "Assessment of different packaging materials on post-harvest quality and shelf life of loose flowers of Tuberose (*Agave amica*)", was carried out during the year 2025–26 in the laboratory of Krantikari Debridhur College of Horticulture and Research Station, Jagdalpur, Chhattisgarh. The experiment comprised ten packaging treatments, namely T_1 (Control), T_2 (Polyethylene 200-gauge), T_3 (Polyethylene 400-gauge), T_4 (Cardboard box), T_5 (Bamboo basket), T_6 (Newspaper), T_7 (Butter paper), T_8 (Arecanut sheath), T_9 (Banana leaf), and T_{10} (Peepal leaf). These treatments were evaluated using a Completely Randomized Design (CRD) with three replications**.** Among all the packaging materials evaluated, T_3 (Polyethylene 400-gauge) showed the best performance in maintaining the post-harvest quality of loose tuberose flowers. It recorded the highest flower diameter (7.86 mm and 7.80 mm), flower length (58.87 mm and 56.90 mm) at 24 and 48 hours of storage, respectively, along with the maximum fresh weight (3.76 g), final weight (3.06 g), and shelf life (6.60 days). In contrast, T_1 (Control) exhibited the poorest performance and recorded the shortest shelf life (2.18 days). Polyethylene 400-gauge effectively maintained moisture, freshness, colour, fragrance, and marketability of flowers during storage. The superior performance of this packaging material can be attributed to reduced moisture loss, maintenance of high relative humidity, and the creation of a favourable modified atmosphere within the package, which delayed senescence and preserved flower quality. Therefore, Polyethylene 400-gauge was found to be the most suitable packaging material for extending shelf life and maintaining the post-harvest quality of loose tuberose flowers under ambient storage conditions.

***Keywords*:** Loose flowers, packaging materials, polyethylene 400-gauge, shelf life, post-harvest quality.

Introduction

Tuberose (*Agave amica*), belonging to the family Asparagaceae, is an important ornamental flower crop valued for its attractive appearance, intense fragrance, and diverse applications in the floriculture, perfume, cosmetic, and pharmaceutical industries. Native to Mexico, it was introduced to India during the sixteenth century and is now widely cultivated in tropical and subtropical regions. Popularly known as Rajanigandha, the crop is extensively grown for both loose and cut flower production owing to its high commercial value and year-round demand. It is estimated that tuberose is commercially cultivated over an area of about 30,000 hectares in India (Singh *et al*., 2010).

Tuberose is a perennial bulbous plant producing long spikes of waxy white, highly fragrant flowers with excellent keeping quality. Based on flower morphology, cultivars are classified into single, semi-double, and double types. Single-flowered cultivars are primarily cultivated for loose flower production and essential oil extraction, whereas double-flowered cultivars are preferred for cut flower production, bouquets, and floral arrangements. The major share of tuberose consumption is in the form of loose flowers, followed by cut flowers and essential oil extraction (Singh *et al*., 2010). The flowers are widely used in garlands, bouquets, religious offerings, weddings, and other social functions. In addition, tuberose flowers are an important source of essential oil and floral absolute used in perfumes, cosmetics, incense sticks, and other scented products. Owing to its ornamental, economic, aromatic, and medicinal significance, tuberose occupies a prominent position among commercial flower crops. Flowers are among the most attractive components of ornamental plants and contribute greatly to aesthetic and environmental enhancement (Tariq *et al*., 2012).

Due to their highly perishable nature, proper post-harvest handling is essential to maintain the quality of tuberose flowers (Hardenburg, 1990). Packaging is an important tool for controlling flower quality throughout the distribution chain. Besides preventing mechanical damage, packaging acts as a barrier between internal and external environments, protecting flowers from unfavorable conditions while enabling the development of a suitable microclimate within the package (Nowak *et al.*, 1991). Packaging also protects flowers from physical injury, reduces water loss during transportation, and enhances shelf life (Majumdar *et al*., 2014 and Panwar *et al.*, 2020). Proper packaging helps maintain high relative humidity and an appropriate balance of oxygen and carbon dioxide concentrations, thereby reducing respiration and moisture loss (Anzueto and Rizve, 1985 and Bhowmik and Hulbert, 1989).

Among various packaging materials, polyethylene has been reported to be particularly effective in extending the shelf life of flowers. Polyethylene packaging creates a modified atmosphere by increasing carbon dioxide concentration and maintaining high relative humidity, which slows respiration and delays senescence (Viresh *et al*., 2023). Despite the commercial importance of loose tuberose flowers, only limited studies have been conducted on extending their shelf life through the use of different packaging materials (Nagaraja *et al.*, 1999a and Nagaraja *et al*., 1999b). Therefore, the selection of suitable packaging materials is crucial for preserving post-harvest quality and extending the shelf life of loose tuberose flowers

Material and methods

Experimental details

The present investigation on Loose Flowers of Tuberose (*Agave amica*) was conducted during the year 2025–26 in the laboratory of Krantikari Debridhur College of Horticulture and Research Station, Jagdalpur, Chhattisgarh. The experiment was laid out in a Completely Randomized Design (CRD) with three replications under ambient condition to evaluate the effect of various packaging materials on the post-harvest quality and shelf life of loose tuberose flowers. The treatments comprised T_1 (Control), T_2 (Polyethylene 200-gauge), T_3 (Polyethylene 400-gauge), T_4 (Cardboard box), T_5 (Bamboo basket), T_6 (Newspaper), T_7 (Butter paper), T_8 (Arecanut sheath), T_9 (Banana leaf) and T_{10} (Peepal leaf). The data recorded from the experiment were statistically analyzed using the mean values of three replications for each treatment. The standard error of the mean was calculated, and the significance of treatment effects was evaluated through one-way Analysis of Variance (ANOVA).

Results and Discussion

Fresh weight of flowers (g)

The data pertaining to fresh weight of loose flowers of tuberose (*Agave amica)* as influenced by different packaging materials are presented in Table 1 and Fig.1.

The maximum fresh weight under T_3 (Polyethylene 400-gauge) (3.76 g) was recorded which was significantly *at par* with T_2. Whereas, the minimum fresh weight was recorded in T_1 (control) (1.93 g).

The higher fresh weight observed in polyethylene 400-gauge packaged flowers attributed to the creation of a favourable modified atmosphere and reduced moisture loss from the florets. Polyethylene packaging minimizes transpiration and maintains higher relative humidity around the flowers, thereby preserving cellular turgidity and fresh weight during storage. On the other hand, the lowest fresh weight recorded in the control treatment due to rapid moisture loss and unrestricted transpiration under ambient conditions, leading to loss of cellular water and reduction in flower weight. The findings of the present investigation are in close conformity with the results reported by Nagaraja *et al*. (1999a) and Khongwir *et al.* (2017) in tuberose, as well as by Ravi *et al*. (2004) and Karuppaiah *et al*. (2006) in jasmine.

Final weight of flowers (g)

The data pertaining to final weight of loose flowers of tuberose (*Agave amica)* as influenced by different packaging materials are presented in Table 1 fig. 2.

The maximum final weight was recorded in T_3 (Polyethylene 400-gauge) (3.06 g) followed by T_2 and T_7. Whereas the minimum final weight was observed in T_1 (control) (0.88 g).

The higher final weight recorded in Polyethylene 400-gauge attributed to their superior ability to conserve moisture and maintain a favourable microenvironment around the flowers during storage. Polyethylene packaging reduces transpiration losses and helps retain higher relative humidity inside the package, thereby minimizing water loss from the florets and preserving their weight. It is evident from the results that thicker polyethylene films act as an effective barrier to moisture and gas exchange, resulting in better retention of water content and delayed senescence of florets. In contrast, flowers stored in the control treatment experienced rapid moisture loss due to direct exposure to ambient conditions, resulting in complete deterioration and zero final weight. The findings of the present investigation are in close conformity with the results reported by Khongwir *et al.* (2017) in tuberose.

Flower diameter (mm)

The data on flower diameter of loose tuberose flowers (*Agave amica*) under different packaging materials at 24 and 48 hours of storage are presented in Table 1 and Fig.3.

At 24 hours of storage, the maximum flower diameter was recorded in T_3 (Polyethylene 400-gauge) (7.86 mm), which was significantly *at par* with T_2, T_7, T_8 and T_9, while the minimum diameter was observed in T_1 (Control) (5.94 mm).

At 48 hours of storage, the highest flower diameter was recorded in T_3 (Polyethylene 400-gauge) (7.80 mm), significantly *at par* with T_2, whereas the minimum diameter was observed in T_1 (Control) (1.35 mm).

Superior performance in Polyethylene 400-gauge resulted from better moisture retention and reduced transpiration, maintaining cellular turgidity and flower size, whereas rapid moisture loss in the control caused the lowest flower diameter. Comparable findings were supported by Sankar and Bhattacharjee (2003) in roses, Khongwir *et al.* (2017) in tuberose and S Kumaresan (2023) in jasmine.

Flower length (mm)

The data on flower length of loose tuberose flowers (*Agave amica*) under different packaging materials are presented in Table 1 and fig. 4.

At 24 hours of storage, the maximum flower length was recorded in T_3 (Polyethylene 400-gauge) (58.87 mm), which was significantly *at par* with T_2 and T_7, while the minimum flower length was observed in T_1 (Control) (43.70 mm).

At 48 hours of storage, the highest flower length was recorded in T_3 (Polyethylene 400-gauge) (56.90 mm), significantly *at par* with T_2, whereas the minimum flower length was observed in T_1 (Control) (12.11 mm) due to complete flower deterioration.

Superior flower length was recorded in Polyethylene 400-gauge due to their better moisture retention and maintenance of high relative humidity, preserving cellular turgidity and minimizing tissue shrinkage, while rapid moisture loss in the control led to wilting and accelerated senescence. These findings are in agreement with the reports of Chaudhuri *et al.* (2015) in jasmine and Khongwir *et al.* (2017) in tuberose.

Shelf life (days)

The data pertaining to shelf life of loose tuberose flowers (*Agave amica*) as influenced by different packaging materials are presented in Table 1 and fig. 5.

The maximum shelf life was recorded in T_3 (Polyethylene 400-gauge) (6.60 days), which was significantly *at par* with T_2 and T_7. In contrast the minimum shelf life was observed in T_1 (Control) (2.18 days).

The shelf life of loose tuberose flowers was significantly influenced by the packaging materials used. The longest shelf life was observed in Polyethylene 400 gauge. This is due to the maintenance of a favourable microenvironment with higher relative humidity inside the polyethylene packages, which minimized moisture loss and reduced respiration rates. As a result, flower freshness was maintained for a longer duration, leading to delayed senescence and extended shelf life. The result of similarly finding with the Nirmala and Reddy (1993) in jasmine, Yeluguri and Girvani (2013) and Verma and Jhanji (2019) in marigold under ambient condition.

Table 1 : Effect of different packaging materials on various post-harvest parameters of tuberose flowers

Treatment	Fresh weight	Final weight	Flower diameter		Flower length		Shelf life (Days)
			24hrs	48hrs	24hrs	48hrs	
T_1	1.93	0.88	5.94	1.35	44.70	12.11	2.18
T_2	3.67	2.66	7.77	7.57	57.37	55.54	6.42
T_3	3.76	3.06	7.86	7.80	58.87	56.90	6.60
T_4	3.11	1.84	6.85	4.65	48.71	26.09	5.02
T_5	2.56	0.96	6.08	2.07	45.36	17.09	2.78
T_6	2.87	1.72	6.56	4.26	46.88	22.06	4.59
T_7	3.45	2.16	7.62	6.12	54.86	40.35	6.18
T_8	3.32	2.05	7.55	5.53	52.79	35.97	5.84
T_9	3.23	1.97	7.37	5.26	49.68	31.53	5.64
T_{10}	2.75	1.05	6.46	3.09	45.94	21.05	4.11
CD (0.05%)	0.26	0.16	0.54	0.45	4.54	3.12	0.43
SE(m)±	0.09	0.05	0.18	0.15	1.53	1.05	0.14
CV (%)	4.90	5.05	4.50	5.54	5.25	5.70	5.02

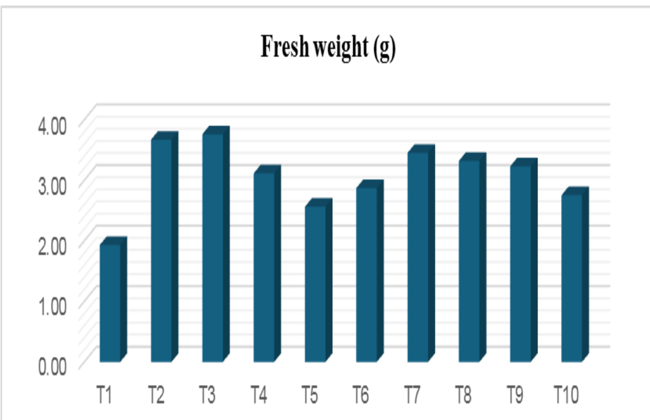

Fig. 1: Effect of different packaging materials on fresh weight of tuberose

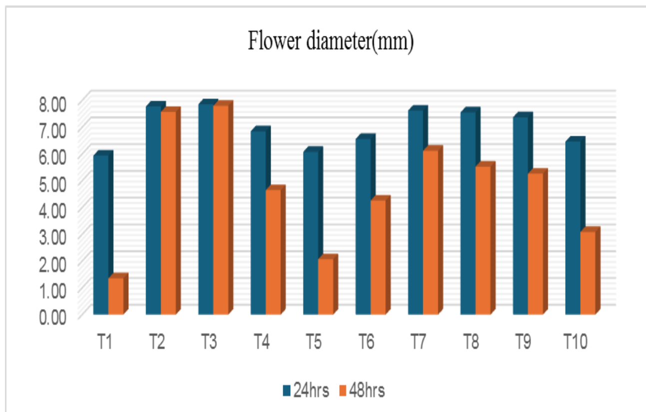

Fig. 3 : Effect of different packaging materials on flower diameter of tuberose

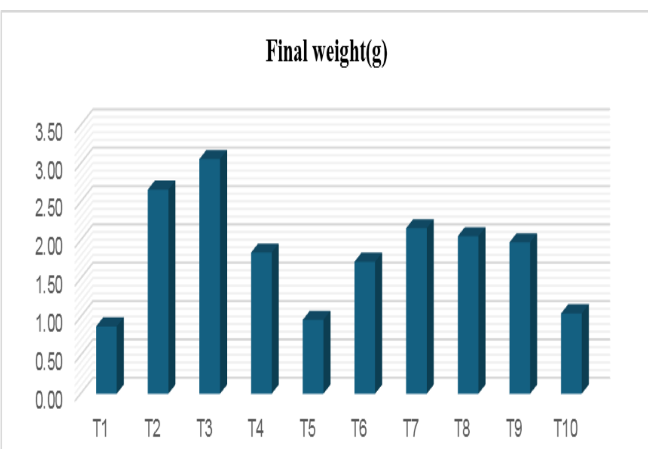

Fig. 2: Effect of different packaging materials on final weight of tuberose

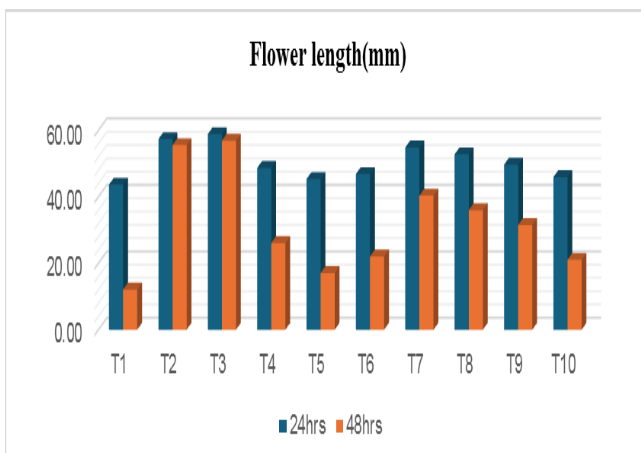

Fig. 4 : Effect of different packaging materials on flower length of tuberose

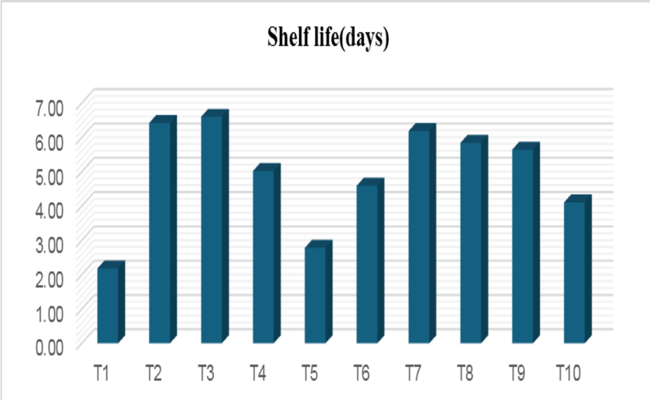

Fig. 5 : Effect of different packaging materials on shelf life of tuberose

Conclusion

Among the treatments, Polyethylene 400-gauge proved to be the most effective, maintaining higher fresh weight, final weight, flower diameter, and flower length, which ultimately resulted in the longest shelf life. In contrast, Control recorded the lowest values for these parameters and exhibited the shortest shelf life. Therefore, Polyethylene 400-gauge packaging is recommended for preserving the physical quality and extending the shelf life of loose tuberose flowers under ambient storage conditions.

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