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Post Harvest Packaging Technology for Gladiolus cv. Nova Lux

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ABSTRACT

Gladiolus is one of the most important cut flowers in the world**.** Main problem in gladiolus cut flower is short vase life of 4 to 8 days. An experiment was conducted at the Department of Horticulture, Lovely Professional University, Punjab, India to observe the effect of various packaging materials on post-harvest life and quality of gladiolus. The gladiolus flower was treated with eight treatment combinations (T_1–CFB box, T_2–Bubble sheet, T_3–Brown paper, T_4–LDPE 100 microns, T_5–LDPE 50 microns, T_6–LDPE 30 Microns, T_7–HDPE 50 microns and T_8–PVC film. Among all these treatments, the treatment T_4 (LDPE 100 microns) showed the best results in terms of water uptake (ml), flower weight (g), dry weight (g), number of florets opened, number of florets remained closed, floret opening (%), days to open 5th floret, days to wither 5th floret, days taken to discolouration of the floret, stem diameter (mm), pH of the solution, electrolyte leakage (%) and vase life (days) which was extended to 18 days after storing the flowers with packaging and storing at 4°C. Therefore, it was concluded that LDPE 100 microns can be commercially used for packaging and transportations of flowers and improving post harvest life of gladiolus cv. Nova lux.

Key words: Packaging, Nova lux, HDPE, LDPE

INTRODUCTION

Gladiolus is one of the highest value cut flowers in the floriculture industry, known as “Garden glad” or “sword lily”. It belongs to the family Iridaceae and is also referred to as the ‘Queen of bulbous flowers’. The spikes of gladiolus flowers comprise many florets with different forms and sizes, which are either smoothly ruffled or crinkled tepals. In India, farmers predominantly grow gladiolus cv. Nova lux as a cut flower, resulting in significant production. Despite the substantial production of gladiolus cv. Nova lux cut flowers, there is still a loss of 30-40% (Nath *et al.,* 2018). To mitigate such post-harvest losses, there is a need for practices or management techniques that can help gladiolus flowers to remain fresh for a longer period. So, one of the most important methods used now-a-days to keep flowers fresh for a long period of time and increase their market value is by packaging flowers using different packaging materials and then storing these flowers at a temperature of 2-4°C during transportation (Dole and Faust, 2021; Happy *et al*., 2022). The prices of cut flowers can increase up to 9-10 times through post-harvest management and value addition during marketing in the domestic market or for export. Appropriate packaging helps in increasing the quality and vase life of spikes. The different packaging materials that can be used to extend the vase life of flower these materials are: LDPE, HDPE, bubble sheet, CFB boxes, brown paper, butter paper, plastic bags, cellophane paper, newspaper, PVC film, etc. which help in slowing down the process of opening of florets, oxygen production and increase rate of production of carbon dioxide. Additionally, packaging with different materials and then storing flowers in cold storage helps in reducing the rate of ethylene production, which ultimately aids in the post-harvest life of gladiolus. Storage refers to the conditions of packaged flowers kept in a controlled environment before they are sold or used. Ideal storage conditions for gladiolus include a cold temperature (2-4°C) and high humidity (90-95%) to prevent dehydration and to maintain the freshness of flowers. Therefore, different packaging materials were used to standardize the best ones which can extend the post-harvest life of gladiolus (*Gladiolus grandiflorus*) cv. Nova lux.

MATERIALS AND METHODS

The study was conducted in the Department of Horticulture, Lovely Professional University Phagwara, Punjab, India in the year 2023. Uniform cut flowers of cv. Nova lux were harvested from the farm early in the morning and were brought to the laboratory in a bucket containing water. The spikes were prepared by cutting them to a uniform length of 60 cm. Then these cut stems were pulsed in 20% sucrose for 16 h before packaging. The spikes were wrapped in different packaging materials like T_1–CFB box, T_2–Bubble sheet (20 micron), T_3–Brown paper, T_4–LDPE 100 microns, T_5–LDPE 50 microns, T_6–LDPE 30 nicrons, T_7–HDPE 50 microns and T_8–PVC film 70 microns. The spikes were packaged and stored in refrigerator at 4°C for 10 days. The spikes were removed from packaging materials and transferred to pure water in laboratory. The experiments were replicated three times and laid in completely randomized design. The observations *viz.,* water uptake (ml), change in flower weight(%), dry weight (g), number of florets opened, number of florets remaining closed, floret opening(%), vase life, days to open 5th floret, days to wither 5th floret, days taken to discolouration of floret, stem diameter (mm), pH of the solution and electrolyte leakage (%) were recorded and the data were subjected to analysis by using Web Agri Stat Package 1.0 of ICAR Research Complex for Goa, India.

RESULTS AND DISCUSSION

The effect of different packaging materials on water uptake (ml) by gladiolus cut stem was recorded on 2nd, 4th, 6th and 8th day. Table 1 shows an increasing trend in water uptake till the 4th day of vase life and then decreased. The maximum (111.26, 130.33, 81.69 and 41.48 ml) water uptake was observed in treatment T_4 which was followed (108.91, 124.03, 79.96 and 53.94 ml) by T_8 on 2nd, 4th, 6th and 8th day, respectively. However, minimum (70.24, 74.65, 47.49 and 34.33 ml) water uptake was observed in treatment T_2 on 2nd, 4th, 6th and 8th day, respectively. The maximum water uptake in LDPE 100 microns might be as flowers packaged maintained high relative humidity which protected water loss helping in absorbing more water after cold storage. Packaging materials help in creating microclimate around flower which in turn minimizes water loss and increases water uptake (De and Singh, 2016).

Table 1. Effect of different packaging materials on water uptake (ml) in gladiolus cv. Nova lux

Treatment	Water uptake (ml)			
	2nd day	4th day	6th day	8th day
T_1 (CFB box)	96.35	100.33	61.21	29.34
T_2 (Bubble sheet 20 micron)	70.24	74.65	47.49	34.33
T_3 (Brown paper)	87.76	93.50	65.49	24.48
T_4 (LDPE 100 micron)	111.26	130.33	81.69	41.48
T_5 (LDPE 50 micron)	107.66	119.69	76.73	47.33
T_6 (LDPE 30 micron)	105.97	118.37	58.57	37.37
T_7 (HDPE 50 micron)	97.73	107.41	72.58	44.36
T_8 (PVC film 70 micron)	108.91	124.40	79.96	53.49
C. D. (P = 0.05)	1.747	1.908	1.182	0.776
C. V.	1.028	1.015	1.005	1.148
S. E.	1.019	1.215	0.466	0.201

The effect of different packaging materials on floret opening % by gladiolus cut stem was recorded on 2nd, 4th, 6th and 8th day showed increasing trend in flower opening till the 4th day of vase life after which flower opening was decreased (Table 2). Significantly, maximum (13.2, 22.33, 79.55, 35.29 and 29.34%) floret

Table 2. Effect of different packaging materials on floret opening (%) in gladiolus cv. Nova lux

Treatment	Floret opening (%)				
	1st day	2nd day	4th day	6th day	8th day
T_1 (CFB box)	20.10	16.41	51.27	21.50	14.21
T_2 (Bubble sheet 20 micron)	11.13	20.41	60.32	26.42	20.26
T_3 (Brown paper)	16.23	23.35	58.29	28.53	14.76
T_4 (LDPE 100 micron)	13.20	22.33	79.55	35.29	29.34
T_5 (LDPE 50 micron)	9.64	15.36	78.52	33.39	25.45
T_6 (LDPE 30 micron)	11.72	28.50	74.32	18.35	18.43
T_7 (HDPE 50 micron)	12.15	21.52	62.59	23.56	11.31
T_8 (PVC film 70 micron)	8.41	19.40	68.08	30.41	22.30
C. D. (P = 0.05)	0.249	0.415	1.339	0.659	0.391
C. V.	1.121	1.148	1.161	1.400	1.156
S. E.	0.021	0.058	0.599	0.145	0.815

opening was observed in treatment T_4 which was followed (9.64, 15.36, 78.52, 33.39 and 25.45%) by T_5 on 2nd, 4th, 6th, 8th day, respectively. However, minimum (20.10, 16.41, 51.27, 21.50 and 14.21%) floret opening was observed in treatment T_1 on 2nd, 4th, 6th, 8th day, respectively. The maximum floret opening in treatment T_4 (LDPE 100 micron) might be as LDPE creates modified atmosphere that promotes flower development and inhibits ethylene production. This modified atmosphere created by LDPE packaging helps in reducing oxygen level which in turn increases carbon dioxide around the flowers (Maurya *et al.*, 2020). It helps in ageing and inhibits the production of plant hormone ethylene which helps in delaying of senescence, prolonging life of flowers and promoting floret opening. LDPE packaging also helps in maintaining high relative humidity (Gaikwad *et al.,* 2017).

The effect of different packaging materials on change in % fresh weight recorded on 2nd, 4th, 6th, and 8th day showed that there was increasing trend till the 4th day of vase life after which change in fresh weight % was decreased (Table 3). Significantly, the maximum (64.68, 70.68, 55.80 and 34.62%) change in fresh weight % was observed in T_4 (LDPE 100 microns) which was followed (60.94, 68.76, 50.77 and 29.61%) by T_5 (LDPE 50 microns) on 2nd, 4th, 6th, 8th day, respectively. However, minimum (41.7, 50.15, 32.82 and 18.44%) change in fresh weight % was observed in treatment T_1 on 2nd, 4th, 6th, 8th day, respectively. The maximum flower weight % in treatment T_5 (LDPE 100 microns) might be as LDPE packaging helps in maintaining flower weight after storage by reducing water loss and keeping flowers hydrated (De and Singh, 2016). Flowers stored in cold temperature lose water through transpiration (Fanourakis *et al.*, 2021). LDPE packaging creates barrier which reduces water loss from flowers which helps in maintaining a high relative humidity around flowers which in turn promotes water uptake and results in increase in flower weight after cold storage. Similar findings were reported by (Happy *et al.*, 2022) in tuberose.

Significantly maximum (10.78) total number of florets was observed in treatment T_4 which was followed by treatment T_7 (9.11). However, minimum (7.52) total number of florets was recorded in treatment T_5 (Table 4). The maximum (9.5) number of florets opened was observed in treatment T_4 (LDPE 100 microns) which was followed (7.19) by T_7 (HDPE 50 micron). However, minimum (4.41) number of florets opened was observed in treatment T_1 (CFB box). Also, minimum (1.39) number of florets remained closed was observed in treatment T_4 (LDPE 100 micron) which was at par (1.90) with T_5 (LDPE 50 micron). However, maximum (3.44) number of florets that remained closed was observed in treatment T_1 (CFB box) which was at par (3.36) with T_3 (Brown paper). The maximum number of florets opened in treatment T_4 (LDPE 100 micron) might be LDPE packaging material, which reduced rate of respiration and water loss which helped to prolonging vase life and which ultimately helped in increased flower opening and less dropping off flower prematurely. Similar findings were reported by Happy *et al.* (2022) in tuberose.

Table 3. Effect of different packaging materials on change in fresh weight (%)in gladiolus cv. Nova lux

Treatment	Change in fresh weight (%)			
	2nd day	4th day	6th day	8th day
T_1 (CFB box)	41.70	50.15	32.82	18.44
T_2 (Bubble sheet 20 micron)	44.70	53.03	34.77	22.65
T_3 (Brown paper)	51.75	55.92	41.91	25.68
T_4 (LDPE 100 micron)	64.68	70.68	55.80	34.62
T_5 (LDPE 50 micron)	60.94	68.76	50.77	29.61
T_6 (LDPE 30 micron)	54.78	60.85	48.66	32.83
T_7 (HDPE 50 micron)	48.90	57.67	54.79	30.56
T_8 (PVC film 70 micron)	58.72	63.72	52.82	27.60
C. D. (P = 0.05)	1.051	1.215	1.006	0.623
C. V.	1.139	1.168	1.248	1.297
S. E.	0.368	0.493	0.338	0.130

Table 4. Effect of different packaging materials on total number of florets, number of florets opened and number of florets remained closed in gladiolus cv. Nova lux

Treatment	Total no. of florets	Number of florets opened	Number of florets remained closed
T_1 (CFB box)	7.71	4.41	3.44
T_2 (Bubble sheet 20 micron)	8.55	6.61	2.89
T_3 (Brown paper)	8.55	5.60	3.36
T_4 (LDPE 100 micron)	10.78	9.50	1.39
T_5 (LDPE 50 micron)	7.52	6.79	1.90
T_6 (LDPE 30 micron)	7.74	5.70	2.81
T_7 (HDPE 50 micron)	9.11	7.19	2.48
T_8 (PVC film 70 micron)	8.42	6.15	2.86
C. D. (P = 0.05)	0.165	0.115	0.066
C. V.	1.112	1.026	1.449
S. E.	0.145	0.071	0.023

The maximum (5.6) days to open 5th floret was observed in treatment T_4 (LDPE 100 microns) which was at par with T_8 (PVC film 70 micron; 5.34) and T_7 (5.07; Table 5). However, minimum (3.29) days to open 5th floret was recorded in treatment T_1 (CFB Box) which was at par (3.6) with T_3 (Brown paper). Also, maximum (7.3) days to wither 5th floret was observed in treatment T_4 (LDPE 100 microns) which was at par (7.15) with treatment T_8 (PVC film). However, minimum (4.94) days to wither 5th floret was recorded in T_3 (Brown paper). The maximum days to open 5th floret in treatment T_4 (LDPE 100 microns) might be as LDPE packaging is impermeable to moisture and gases which will help to maintain a consistent level of humidity around flowers. It can help in the drying or withering of flowers prematurely. Also, LDPE packaging can help in reducing amount of exposure that flowers have towards light which can cause ageing more quickly. Blocking light by using LDPE helps in slowing down ageing and extending the vase life of flowers. The maximum (9.70) days taken to discolouration of floret was observed in treatment T_4 (LDPE 100 micron) which was followed (8.87) by treatment T_8 (PVC film 70 micron). However, minimum (6.03) days taken to discolouration of floret was observed in treatment T_3 (Brown paper), which was at par (6.2) with T_1 (CFB box). The maximum days taken for discolouration might be as LDPE helps in preventing moisture lose thus slowing the deterioration process of flowers and extending the vase life of flowers (Thakur, 2020). LDPE packaging also acts as a barrier against ethylene exposure, which helps to slow down the ageing process and extend the vase life of flowers (Sadhukhan *et al.*, 2021).

Table 5. Effect of different packaging materials on days to open 5th floret, days to wither 5th floret and days to discolouration of floret in gladiolus cv. Nova lux

Treatment	Days to open 5th floret	Days to wither 5th floret	Days to discolouration of floret
T_1 (CFB box)	3.29	5.30	6.20
T_2 (Bubble sheet 20 micron)	4.08	6.08	7.18
T_3 (Brown paper)	3.60	4.94	6.03
T_4 (LDPE 100 micron)	5.60	7.30	9.70
T_5 (LDPE 50 micron)	4.94	6.70	8.43
T_6 (LDPE 30 micron)	4.70	6.15	8.45
T_7 (HDPE 50 micron)	5.07	6.83	8.08
T_8 (PVC film 70 micron)	5.34	7.15	8.87
C. D. (P = 0.05)	0.086	0.112	0.123
C. V	1.085	1.022	0.904
S. E.	0.002	0.004	0.005

The maximum (83.08, 75.81 mm) stem diameter was observed in treatment T_4 (LDPE 100 micron) which was followed (79.51, 70.83 mm and 78.73, 70.00 mm) by treatment T_5 (LDPE 50 micron) and T_7 (HDPE 50 micron), respectively (Table 6). However, a minimum (64.79, 49.00 mm) stem diameter was observed in treatment T_3 (Brown paper). The maximum stem diameter in treatment T_4 (LDPE 100 micron) might be due to wrapping materials creating a modified atmosphere (MA) by decreasing the rate of respiration with the use of high carbon dioxide and limited oxygen concentration, which helps in decreasing the respiration rate, decreasing stored food loss and providing enough energy to spike for successful floret opening and more diameter. It also helps in maintaining stem diameter by reducing water loss and physical damage during storage and transportation. The minimum (5.35, 6.35) pH value was observed in treatment T_4 (LDPE 100 microns) which was

Table 6. Effect of different packaging materials on stem diameter (mm) and change in pH of water in gladiolus of floret cv. Nova lux

Treatment	Stem diameter (mm)		Change in pH of water	
	Initial days	Final day	Initial days	Final day
T_1 (CFB box)	66.37	51.07	8.93	9.90
T_2 (Bubble sheet 20 micron)	69.89	55.15	6.70	8.02
T_3 (Brown paper)	64.79	49.00	6.75	9.05
T_4 (LDPE 100 micron)	83.08	75.81	5.35	6.35
T_5 (LDPE 50 micron)	79.51	70.83	6.40	6.90
T_6 (LDPE 30 micron)	75.73	67.14	7.13	8.05
T_7 (HDPE 50 micron)	78.73	70.00	7.75	7.85
T_8 (PVC film 70 micron)	72.90	60.23	6.94	8.10
C. D. (P = 0.05)	1.229	1.339	0.103	0.097
C. V.	0.961	1.240	0.850	0.697
S. E.	0.504	0.599	0.004	0.003

at par (6.4, 6.90) with T_5 (LDPE 50 microns). However, maximum (8.93, 9.90) pH value was recorded in treatment T_1 (CFB box). The change in pH might be due to the use of packaging material, which can directly influence the rate of respiration and microbial growth (Perumal *et al*., 2022). During cold storage, flowers continue to undergo respiration, which can lead to the production of carbon dioxide and decrease pH (da Costa *et al*., 2021). If the flowers are packaged in LDPE sheets, these sheets act as a barrier against the diffusion of carbon dioxide around the flowers. This increased concentration of carbon dioxide can slow down respiration and decrease the pH of water (Yadav *et al.,* 2022). Additionally, LDPE packaging can lead to the production of organic acids, which can decrease the pH. By inhibiting microbial growth, LDPE packaging can help in reducing the accumulation of organic acids, which slows down the rate of pH decrease (Martins *et al*., 2023).

The minimum (32.65 and 38.52%) electrolyte leakage (%) was observed in treatment T_4 (LDPE 100 microns) which was followed (34.46 and 42.76%) by treatment T_5 (LDPE 50 microns). However, maximum (61.46 and 67.18%) electrolyte leakage was observed in treatment T_8 (Table 7). The minimum electrolyte leakage might be as LDPE packaging has ability to retain moisture, which helps to reduce the dehydration of flowers during cold storage. Dehydration can damage the cell membranes, which leads to electrolyte leakage. Keeping flowers hydrated by using LDPE packaging helps in maintaining the integrity of the cell membrane and reduces electrolyte leakage. LDPE packaging helps in protecting the flowers from physical damage during transportation and storage, which helps in maintaining the structural integrity of flowers and reduces the likelihood of cell membrane damage (Poonsri, 2021). LDPE packaging can also act as a barrier against ethylene exposure, which helps to slow down the ageing process and reduces the likelihood of electrolyte leakage (Ghoora and Srividya, 2020). The maximum (6.28) dry weight (g) was observed in treatment T_4 (LDPE 100 microns) which was at par (6.11) with treatment T_5 (LDPE 50 microns). However, minimum (3.10) dry weight (g) was observed in treatment T_3 (Brown paper) which was at par (3.28) with treatment T_1 (CFB box). The maximum dry weight may be as LDPE packaging helps in retaining moisture in cut flowers, which prevents them from losing weight due to dehydration. Respiration is a process that occurs in plants during this process they consume oxygen and produce carbon dioxide. This process can cause flowers to lose weight and leads to discolouration. LDPE packaging helps to reduce the rate of respiration in cut flowers by limiting amount of oxygen available, which helps to maintain flower weight. LDPE helps to protect the flowers from physical damage during transportation and storage by reducing bruising, bending, or other damage that causes flowers to lose weight and deteriorate more quickly (Choudhary and Devi, 2021).

Significantly maximum (8.76) vase life (days) was observed in treatment T_4 (LDPE 100 microns) which was at par (8.15) with treatment T_5 (LDPE 50 microns). However, minimum (5.30) vase life was observed in treatment T_1 (CFB box) which was at par (5.70) with T_3 (Brown paper). The LDPE packaging can result in maximum vase life as gladiolus flowers are sensitive to temperature changes, if they are exposed to high temperature for

Table 7. Effect of different packaging materials on electrolyte leakage (%) and vase life in gladiolus cv. Nova lux

Treatment	Electrolyte leakage (%)		Dry weight (g)	Vase life (days)
	Initial days	Final day		
T_1 (CFB box)	62.39	65.02	3.28	5.30
T_2 (Bubble sheet 20 micron)	52.68	60.30	5.26	6.18
T_3 (Brown paper)	43.60	51.58	3.10	5.70
T_4 (LDPE 100 micron)	32.65	38.52	6.28	8.76
T_5 (LDPE 50 micron)	34.46	42.76	6.11	8.15
T_6 (LDPE 30 micron)	49.55	51.31	5.04	6.64
T_7 (HDPE 50 micron)	40.71	55.56	5.52	7.19
T_8 (PVC film 70 micron)	61.46	67.18	4.60	7.86
C. D. (P = 0.05)	0.793	1.012	0.093	0.107
C. V.	0.971	1.082	1.091	0.889
S. E.	0.21	0.342	0.003	0.004

longer time they can wilt and lose their marketability (Gupta and Kumar, 2018). Packaging helps in regulating temperature by providing insulation and preventing flowers from direct exposure to sunlight. Gladiolus flowers require certain level of moisture to stay fresh. However, if they are exposed to moisture, they may develop fungal diseases that shorten the vase life. Packaging helps in regulating the moisture level by providing ventilation and preventing excess humidity.

CONCLUSION

LDPE 100 microns (T_4) was superior in terms of flower weight (g), vase life (days), water uptake (ml), number of florets opened, number of florets closed, floret opening (%), days to open 5th floret, days to wither 5th floret, days taken to discolouration of floret, stem diameter (mm), pH of solution and electrolyte leakage (%) than rest of the packaging materials. From this, it can be concluded and recommended that LDPE 100 microns can be used for commercial packaging material for transportation and storage of gladiolus cv. Nova lux.

REFERENCES

Choudhary, M. and Devi, R. A. (2021). Influence of packaging material and storage temperature on the shelf life and quality of broccoli: A review. *J. Pharm. Phytochem.* **9**: 233-237.

Da Costa, L. C., De Araujo, F. F., Ribeiro, W. S., De, M. N. and Finger, F. L. (2021). Post-harvest physiology of cut flowers. *Ornamental Hort.* **27**: 374-385.

De, L. C. and Singh, D. R. (2016). Post-harvest management and value addition in orchids. *Int. J. Biol. Sci.* **3**: 14-35.

Dole, J. M. and Faust, J. E. (2021). Post-harvest management. In: *Cut Flowers and Foliage's,* Faust, J., Dole, J. and Boston, M. A. (eds.). CAB International, USA. pp. 342-368.

Fanourakis, D., Papadopoulou, E., Valla, A., Tzanakakis, V. A. and Nektarios, P. A. (2021). Partitioning of transpiration to cut flower organs and its mediating role on vase life response to dry handling: A case study in chrysanthemum. *Post-harvest Biol. Tech.* **181**: 111636. *https://doi.org/10.1016/j.postharvbio.2021.111636.*

Gaikwad, K. K., Singh, S. and Lee, Y. S. (2017). A pyrogallol-coated modified LDPE film as an oxygen scavenging film for active packaging materials. *Prog. Organic Coatings* **111**: 186-195.

Ghoora, M. D. and Srividya, N. (2020). Effect of packaging and coating technique on post-harvest quality and shelf life of *Raphanus sativus* L. and *Hibiscus sabdariffa* L. microgreens. *Foods* **9**: 653. *https://doi.org/10.3390/foods9050653.*

Gupta, S. and Kumar, A. (2018). Effect of different levels of pulsing concentrations on vase life of gladiolus (*Gladiolus grandiflorus* L.). *Int. J. Cur. Microbiol. Appl. Sci.* **7**: 330-334. *Doi: https://doi.org/10.20546/ijcmas.2018.709.040.*

Happy, Chahal, D., Devi, S., Malikand, A. and Kumar S. (2022). Effect of wrapping materials and storage time on shelf life of tuberose (*Polianthes tuberosa* L.). *Agric. Sci. Digest–A Res. J.* **42**: 137-144.

Martins, M., Ribeiro, M. H. and Almeida, C. M. (2023). Physico-chemical, nutritional and medicinal properties of *Opuntia ficus-indica* (L.) Mill. and its main agro-industrial use: A review. *Plants* **12**: 1512. *https://doi.org/10.3390/plants12071512.*

Maurya, V. K., Ranjan, V., Gothandam, K. M. and Pareek, S. (2020). Exogenous gibberellic acid treatment extends green chilli shelf life and maintain quality under modified atmosphere packaging. *Sci. Hort.* **269**: 108934. *https://doi.org/10.1016/j.scienta.2019.108934.*

Nath, A., Meena, L. R., Kumar, V. and Panwar, A. S. (2018). Post-harvest management of horticultural crops for doubling farmer's income. *J. Pharm. Phytochem.* **7**: 2682-2690. *https://www.phytojournal.com/archives/2018/vol7issue1S/PartAN/SP-7-1-708.pdf.*

Perumal, A. B., Huang, L., Nambiar, R. B., He, Y., Li, X. and Sellamuthu, P. S. (2022). Application of essential oils in packaging films for the preservation of fruits and vegetables: A review. *Food Chem.* **375**: 131810. *https://doi.org/10.1016/j.foodchem.2021.131810.*

Poonsri, W. (2021). Effects of active and passive modified atmosphere packaging on biochemical properties of cut Dendrobium orchid flowers. *Heliyon.* **7**: e07197. *doi: 10.1016/j.heliyon.2021.e07197.*

Sadhukhan, R., Chowdhuri, T. K. and Datta, S. K. (2021). Tuberose (*Polyanthes tuberose* Linn./Agave amica). In: *Floriculture and Ornamental Plants.* Springer. pp. 1-52.

Thakur, N. (2020). A review on the effect of storage methods and packaging material on the post-harvest longevity of cut flowers. *Int. J. Chem. Stud.* **8**: 2375-2379.

Yadav, A., Kumar, N., Upadhyay, A., Fawole, O. A., Mahawar, M. K., Jalgaonkar, K. and Mekhemar, M. (2022). Recent advances in novel packaging technologies for shelf-life extension of guava fruits for retaining health benefits for longer duration. *Plants* **11**: 547. *https://doi.org/10.3390/plants11040547.*