www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(9): 2350-2354

www.thepharmajournal.com
Received: 08-06-2022
Accepted: 12-07-2022

Reethu GR
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

MD. Jameel Jhalegar
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

SL Jagadeesh
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Bhuvaneshwari G
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Babu AG
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Pavankumar P
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Umme Seema N
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Corresponding Author:
Reethu GR
College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Standardization of the pre-cooling method for extending the shelf life of tuberose florets stored at 10 °C

Reethu GR, MD. Jameel Jhalegar, SL Jagadeesh, Bhuvaneshwari G, Babu AG, Pavankumar P and Umme Seema N

Abstract
Investigation was carried out to evaluate the effect of different pre-cooling methods to extend shelf life of tuberose florets. The harvested flowers were treated with different pre-cooling methods (Pre-cooling at 4 ºC, hydro cooling at 4 ºC and by use of gel ice packs), followed by treatment with sucrose (10% and 4%) and boric acid (4% and 2%). Analysis was done in terms of physical and chemical characteristics of flowers. Among the three pre-cooling methods, flowers treated with 4% boric and pre-cooled at 4ºC showed better shelf life up to 4 days with least PLW (22.02%), respiration rate (94.43 ml CO_2 kg-^{1} h -^{1}), witnessed minimum wilting (30.37%), recorded least polyphenol enzyme activity without adversely affecting physico-chemical qualities even up to 4 days of storage. Main objective is to study the response of pre-cooling methods and chemicals (sucrose and boric acid) on extending the marketability of tuberose flowers.

Keywords: *Polianthes tuberosa*, boric acid, respiration rate, polyphenol enzyme activity

1. Introduction

Tuberose (*Polianthes tuberosa* L.) belongs to the family Asperagaceae native to Mexico. It is being grown in most of the tropical and sub-tropical countries of world (Asif *et al.*, 2001) [1]. Tuberose is an important commercial cut as well as loose flower crop due to its pleasant fragrance, longer vase-life of spikes, higher returns and wider adaptability to varied climate and soil. They are valued much by the aesthetic world for their beauty and fragrance. Tuberose represents sensuality and is used in aromatherapy for its ability to open the heart and calm the nerves, restoring joy, peace and harmony.

Postharvest performance is worse in tuberose which has been shipped to distant markets. The quality of tuberose flower is affected by various pre and post-harvest factors such as temperature, relative humidity, frequency of irrigation, picking time, nutrition and handling practices Benschop (1993) [2]. The major problem during marketing of tuberose loose flowers is the short shelf life and harvested flowers loss its fresh weight up to 40%,when it is kept overnight due to its high rate of respiration and higher metabolic activity (Reddy 2016) [14]. Lack of standardized packaging method is the main reason which deteriorates the quality of loose flowers.

Proper post-harvest treatments can greatly extend the shelf life of tuberose and routinely be carried out with flowers intended for storage and transport. The different post-harvest technologies available are pre cooling, use of chemical preservatives and different packaging materials. Among these pre-cooling is considered to be critical process in enhancing the post-harvest longevity of the flowers. (Brosnan and Sun 2001) [3]. Pre cooling methods like room cooling, hydro cooling and gel ice pack which helps to remove the field heat, reduce load on refrigerated storage. Several treatments like chemicals, sugar and germicide also increases longevity of tuberose florets (Talukdar and Barooah 2011) [19]. Further, storage of the flowers at low temperatures enhances the post-harvest life. Adequate packaging protects the produce from physical, physiological and pathological deterioration during transport and marketing which helps in extending shelf life by retaining their attractiveness. Use of ethylene absorbent in packages helps in delaying senescence of florets by absorbing ethylene produced inside packages. Treating flower buds with novel chemicals before packaging and transport act as barrier for respiration, moisture loss, to extend the shelf life with better retention of colour and turgidity of petals.

2. Materials and Methods

2.1 Materials

The present investigation was undertaken in the Department of Post-Harvest Technology, University of Horticultural Sciences, Bagalkot, India during the year 2017-18. Prajwal, a commercially important tuberose cultivar grown in this region was used for the study. This cultivar is a single type, having more fragrance, extensively cultivated and used as loose flower. Flower buds were procured from historical place, Badami, near Bagalkot. The unopened flower buds at pin hole stage which were ready to open in subsequent days were harvested in the early morning and they were brought to the laboratory within 2 hours. Three different methods of pre-cooling and two pulsing chemicals were used in the study to evaluate physiological, biochemical and physical characteristics of tuberose.

2.1.1 Pre cooling methods

1. Buds were pre cooled by placing them at 4˚C for about one hour
2. Hydro cooling done by using cold distilled water of temperature 4˚C was noted by using thermometer and buds were pre-cooled for about 5 min.
3. Buds were placed over the gel ice packs (25% weight of buds).

2.2 Methodology

2.2.1 Sucrose and boric acid

Sucrose solution of 4% and 10% were prepared by dissolving 100 gm and 40 gm in 1000 ml of distilled water, respectively.
Boric acid of 2% and 4% was prepared by weighing 2 gm and 4 g separately and dissolved in 100 ml of warm water and volume made up to 1000 ml.
The pre-cooled buds were dipped in solution for about 15 minutes and removed to air dry under ceiling fan. The control buds were dipped in distilled water. The treated as well as untreated buds were placed in baskets and kept under storage 10 °C for further observations.

2.3 Physiological loss in weight (%)

Flowers from each treatment were taken to record the physiological loss in weight (PLW). The weight of the flowers was recorded using precision electronic weighing balance (Make: Sartorius Weighing Technology GmbH, Gottingen, Germany, GE812) before storage as initial weight. On subsequent dates of observation during storage, the flowers were weighed and recorded as final weight on every 2 days intervals and the cumulative PLW was calculated with the following formula and expressed as per cent physiological loss in weight:

$$\text{Physiological loss in weight (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

2.4 Respiration rate (ml CO_2 $kg^{-1}h^{-1}$)

The respiration rate of the flowers packed with different gas composition was measured after taking them out of the polyethylene pouch during their storage.
The tuberose flowers of known volume were enclosed in a hermetic container for specified time and head space gas concentration of CO_2 was measured by piercing the probe of an auto oxygen/carbon dioxide analyzer (Make: Quantek, Model: 902D Dual track) into the container through the septa fixed on the lid of container and direct reading was noted down from the instrument screen. The respiration rate was by using formula:

$$\text{Respiration rate } (\text{mlco}_2\text{kg}^{-1}\text{h}^{-1}) = \frac{\%\ CO_2 \text{ x Head space}}{100 \text{ x Flower weight (kg) x Enclosing time (hr)}}$$

2.5 Wilting (%)

The wilting or fading of florets were recorded on visual basis, count the number of wilted florets and expressed in terms of percentage. The days taken for 50% wilting were noted which ends the shelf life of florets.

2.6 Shelf life (No. of days)

Time taken for development of necrotic symptoms was recorded and shelf life was determined as number of days taken from placing of flower buds till wilting or fading of petals.

2.11 Experimental design and data analysis

The experiment was carried out with 11 treatments and the experiment was repeated 3 times and pooled data was subjected to statistical analysis. Flowers were arranged in Complete Randomised Design. Randomly selected fruits were taken to analyse physiological loss in weight, respiration rate, wilting and shelf life. Statistical analyses were performed using Web Agri Stat Package (WASP) Version 2. Significant differences among means at P = 0.05 were determined by post hoc tests using Duncan's multiple range test.

3. Results and discussion

3.1 Physiological loss in weight (PLW) (%)

Physiological loss in weight (PLW) refers to the loss in weight of the fresh produce due to physiological processes like transpiration, respiration *etc.* In the study, result found that irrespective of pre cooling method used, the PLW of flowers increased from 2nd to 4th (22.62%-40.43%) day of storage at 10 ˚C. On 4th day of storage, minimum PLW of florets (29.56%) was recorded in T_4 and maximum in untreated (control) *i.e.* (59.66%) without pre-cooling. Increase in PLW with increased period of storage due to various physiological activities like transpiration and respiration, which leads to reduction in water content and organic compounds which are used as substrate during respiration of produce, increase in PLW leads to decline in fresh weight of the flowers, similar results are noticed by Sharma (1981) [16] in *Rosa damascena*. This may be attributed to the fact that the pre cooling removes field heat and this low temperature slows down the rate of respiration and evaporation (Brosnan and Sun, 2001) [3].
Among various treatments, minimum PLW was recorded in the florets (buds) pre-cooled at 4 ˚C+4% Boric acid. Pre-cooling and boric acid helps in retaining higher relative water content and lowest rates of PLW, slows down the respiration rate from the harvested cut flowers, accompanied by increased membrane integrity of florets as reported by Mukhopadhyay, 1980 [10] in jasmine and Mujumder *et al.*, 2014 [9] in tuberose and Kumar and Bhattacharjee (2002) [7] in rose. The highest PLW was recorded in case of buds without pre cooling due to residual field heat trapped in the buds leading to rapid loss of moisture and weight.

3.2 Respiration rate (ml CO_2 kg^{-1} hr^{-1})

Respiration is a central process in living cells that mediates the release of energy through the oxidative breakdown of carbon compounds (Starch, sugars and organic acids) and the formation of carbon skeletons necessary for maintenance and synthetic reactions after harvest (Wills *et al.*, 1998) [20]. The respiration rate of flower is an excellent indicator of the metabolic activity of the tissue and thus is a useful guide to the potential shelf life of flowers.

In the study, the treatment T_4 (pre-cooled at 4 °C + 4% Boric acid) recorded minimum respiration rate (91.79 ml CO_2 kg^{-1} hr^{-1}), however irrespective of treatments the respiration rate increased from 2nd to 4th (117.78 ml - 130.14 ml CO_2 kg^{-1} hr^{-1}) day of storage. At the end of 4th day of storage the T_4 recorded minimum respiration rate (94.43 ml CO_2 kg^{-1} hr^{-1}) and maximum in control (167.56 ml CO_2 kg^{-1} hr^{-1}) whereas other treatments showed intermediate results. This may be attributed to the rate of respiration slows down on pre cooling (Brosnan and Sun, 2001) [3] further decrease in the respiration rate of the roses cv. 'Raktagandha' just after pre cooling treatment with cold storage at 4 °C for 24 h and ice cold water spray for 45 min as reported by (Palani kumar *et al.*, 2000) [12]. Use of 4% boric acid showed minimum respiration rate, due to their role in inhibiting respiratory enzymes. Similar findings are also reported in tuberose (Mujumder *et al.*, 2014) [9].

3.3 Wilting of florets

The most common and visibly apparent senescence symptom in flowers is the loss of turgidity of cell, resulting in wilting and death. Loss of weight will cause many perishable commodities to appear wilted or shrivelled under warm, dry conditions within few hours. Wilting occurs at the end of flower life due to increase in water loss by transpiration as reported by (Mayak *et al.*, 1974) [8]. The lesser wilting of florets (30.37%) was seen in the treatment T_4 (pre cooled at 4 °C treated with 4% boric acid), probably due to lesser rate of respiration and evaporation in pre-cooling (Bronsan and Sun, 2001) [3]. The results are in conformity with those of Palani kumar *et al.* (2000) [12] in 'Raktagandha' cut roses, pre cooled at 4 ˚C and in tuberose (Shil *et al.*, 2017) [17]. In addition to pre-cooling, boric acid could have improved water balance by increasing osmotic concentration and pressure potential of petal cells in tuberose, further boric acid also is reported to improve membrane stability and resistance against senescence related changes.

3.4 Shelf life

The term shelf life is commonly used in case of loose flowers and it refers to total life of a flower from the time of its harvesting (In the bud state) to the point of any of the following conditions like loss of colour, wilting, or loss of major aesthetic characteristics. In this investigation pre cooled tuberose showed better shelf life compared to control, this might be due to cooling is related to immediate decrease in whole metabolism of the flower which favours the extension of shelf life, maintaining its quality and reducing expenditures in the subsequent cold storage (Pellegrini and Belle, 2008) [13]. Among different pre cooled methods used florets pre-cooled at 4 ˚C (T_1, T_2, T_3 and T_4) showed maximum shelf life of 4 days, followed by hydro cooling influenced by all physiological parameters similar findings in rose by (Palani kumar 2000) [12], hydro cooling may cause bud damage (Suisuwan 1994) [18]. The action of ethylene can be slowed or stopped by anti-ethylene treatments this can be achieved by boric acid which delayed ethylene production as it is effective substitute for AOA, an inhibitor of ACC synthase activity and also add additional advantage in extending shelf life by improving water balance (Serrano *et al.*, 2001) [15]. It might be assumed that longest shelf life of flowers can be achieved by maintaining low temperature storage is helpful in conservation of flowers, because it reduces degradation of certain enzymes and ethylene production and slows the various process related to senescence (Nowak and Rudnick, 1990) [11].

Table 1: Effect of different pre-cooling methods on physiological loss in weight (%) in buds of tuberose cv. Prajwal stored at 10 °C

Treatments	PLW (%)		Mean
	Days of storage		
	2	4	
T_1: P_1 + 10% sucrose	19.02	33.1	26.06
T_2: P_1 + 2% boric acid	17.50	30.8	24.15
T_3: P_1 + 4% sucrose	20.43	35.16	27.79
T_4: P_1 + 4% boric acid	14.5	29.56	22.02
T_5: P_2 + 10% sucrose	23.03	40.23	31.63
T_6: P_2 + 2% boric acid	22.16	39.16	30.66
T_7: P_2 + 4% sucrose	24.00	42.36	33.18
T_8: P_2 + 4% boric acid	21.33	37.23	29.28
T_9: P_3 + 4% sucrose	27.26	54.70	40.98
T_{10}: P_3 + 4% boric acid	25.00	51.23	38.11
T_{11}: Control	34.50	59.66	47.08
Mean	22.62	40.43	
S.Em ±	0.36	0.38	
CD at (0.01)	1.01	1.07	

P_1: Pre-cooled at 4 °C, P_2: Hydro-cooled at 4 °C, P_3: Gel ice pack

Table 2: Effect of different pre-cooling methods on respiration rate (ml CO_2kg/hr) in buds of tuberose cv. Prajwal stored at 10°C

Treatments	Respiration (mlCO_2kg/hr) Days of storage 2	4	Mean
T_1: P_1 + 10% sucrose	90.33	119.33	104.83
T_2: P_1 + 2% boric acid	95.2	113.93	104.56
T_3: P_1 + 4% sucrose	110.23	120.16	115.19
T_4: P_1 + 4% boric acid	89.16	94.43	91.79
T_5: P_2 + 10% sucrose	123.93	134.43	129.18
T_6: P_2 + 2% boric acid	117.433	126.26	121.84
T_7: P_2 + 4% sucrose	126.2	135.2	130.7
T_8: P_2 + 4% boric acid	113.23	122.43	117.83
T_9: P_3 + 4% sucrose	142.36	153.33	147.84
T_{10}: P_3 + 4% boric acid	134.36	144.5	139.43
T_{11}: Control	154.16	167.56	160.86
Mean	117.78	130.14	
S.Em ±	0.43	0.33	
CD at (0.01)	1.2	0.78	

P_1: Pre-cooled at 4 °C, P_2: Hydro-cooled at 4 °C, P_3: Gel ice pack

Table 3: Effect of different pre-cooling methods on wilting (%) in buds of tuberose cv. Prajwal stored at 10°C

Treatments	Wilting (%) Days of storage 2	4	Mean
T_1: P_1 + 10% sucrose	32.41	43.5	37.41
T_2: P_1 + 2% boric acid	26.33	41.33	33.83
T_3: P_1 + 4% sucrose	29.41	42.41	36.45
T_4: P_1 + 4% boric acid	22.25	38.5	30.37
T_5: P_2 + 10% sucrose	38.25	46.5	42.37
T_6: P_2 + 2% boric acid	36.25	45.28	40.76
T_7: P_2 + 4% sucrose	39.166	48.08	43.62
T_8: P_2 + 4% boric acid	34.58	44.25	39.41
T_9: P_3 + 4% sucrose	42.36	52.25	47.30
T_{10}: P_3 + 4% boric acid	41.25	50.25	45.75
T_{11}: Control	43.25	60.25	51.75
Mean	35.04	46.60	
S.Em ±	0.27	0.26	
CD at (0.01)	0.78	0.74	

P_1: Pre-cooled at 4 °C, P_2: Hydro-cooled at 4 °C, P_3: Gel ice pack

Table 4: Effect of different pre-cooling methods on shelf life, fragrance score and freshness index of tuberose cv. Prajwal stored at 10 °C

Treatments	Shelf life
T_1 : P_1 + 10% sucrose	3.66
T_2 : P_1 + 2% boric acid	3.33
T_3 : P_1 + 4% sucrose	3.00
T_4 : P_1 + 4% boric acid	4.00
T_5 : P_2 + 10% sucrose	3.00
T_6 : P_2 + 2% boric acid	2.66
T_7 : P_2 + 4% sucrose	3.00
T_8 : P_2 + 4% boric acid	3.00
T_9 : P_3 + 4% sucrose	2.00
T_{10} : P_3 + 4% boric acid	2.00
T_{11} : Control	1.00
Mean	2.78
S.Em ±	0.35
CD at (0.01)	0.98

P_1: Pre-cooled at 4°C, P_2: Hydro-cooled at 4°C, P_3: Gel ice pack

Conclusion

On the basis of results obtained in the present investigation on different post-harvest treatments used for extending shelf life of tuberose florets during storage and transport, it can be concluded that, pre-cooling at 4 °C proved is the method followed by hydro cooling and gel ice pack and with respect vase life solutions, sucrose and boric acid were found effective in maintaining freshness of florets by lowering the rate of weight loss, respiration, and wilting thus helping in extending the shelf life of tuberose florets.

Acknowledgments

We are thankful to the Department of Post-Harvest Technology, College of Horticulture, University of

Horticultural Sciences, Bagalkot, Karnataka, India for providing the laboratory facilities and technical support.

References

1. Asif M, Qasim M, Mustafa M. Effect of planting dates on growth, flowering and corm characteristics of tuberose (*Polianthes tuberosa*) cv. Single. Int. J Agric. Biol. 2001;3:391-393.
2. Benschop M. The Physiology of Flower Bulbs. Netherlands; c1993. p. 589-60.
3. Brosnan T, Sun DW. Precooling techniques and applications for horticultural products; A review. International Journal of Refrigeration. 2001 Mar 1;24(2):154-70.
4. Halevy AH, Kofranek AM. The Prevention of Flower Bud and Leaf Abscission in Pot Roses during Simulated Transport1. Journal of the American Society for Horticultural Science. 1976 Nov 1;101(6):658-60.
5. Hashemabadi D. Final Report of Research Project to Islamic Azad University. Rasht Branch, Rasht, Iran. 2011;101.
6. Krishnamoorthy CV, Mythilipriya Poovarasan, Sangavi S. Influence of post-harvest chemical treatments on shelf-life of carnation (*Dianthus caryophyllus* L.) Agric. Update. 2017;12:92-96.
7. Kumar V, Bhattacharjee SK. Shelf life of loose flower as influencd by dipping treatments with different chemicals and cool storage. The Orissa Journal of Horticulture. 2002;30:11-12.
8. Mayak S, Halevy AH, Sagie S, Yoseph-Bravdo B. The water balance of cut rose flowers. Plant. Physiol. 1974;131:15-22.
9. Mujumder J, Singh KP, Perinban S, Singh B, Rai P. Effect of various chemicals with packaging and storage on tuberose (*Polianthes tuberose* L). Hortflora Research Spectrum. 2014;3:138-141.
10. Mukhopadhyay TP, Bose TK, Maiti RG, Misra SK, Biswas J. Effect of chemicals on the postharvest life of jasmine flowers. National Seminar on Production Technology of commercial Flower Crops. Tamil Nadu Agricultural University, Coimbatore; c1980. p. 47-50.
11. Nowak J, Rudnicki RM. Postharvest handling and storage of cut flowers, florist greens and potted plants. 1st Edition, Timber press, Portland; c1990.
12. Palani Kumar S, Chatterjee SR, Cuha SK, Bhattacharjee SK. Effect of pre-cooling and packaging on the biochemical changes of 'Raktagandha' cut roses. J Plant Biol. 2000;27:77-79.
13. Pellegrini MBQ, Belle RA. O que voce precisa saber sobre pos-colheita de flores. Revista Campos Negocios; c2008. p. 69.
14. Reddy. Effect of post-harvest dipping, packaging and storage temperatures on keeping quality of loose flowers of tuberose (*Polianthes tuberose* L). M.S.C. (HORT.), Thesis, Dr. Y.S.R. Hort. Univ., Hyderabad (India); c2016.
15. Serrano M, Amoro A, Pretel MT, Madrid MC, Romojaro, F. Preservative solutions containing boric acid delay senescence of carnation flowers. Postharvest Biol and Technol. 2001;23:133-142.
16. Sharma V. Biochemical changes accompanying petal development in Rosa damascena. Pl. Biochem. J 1981;8:13-16.
17. Shil S, Chakrabarty, Shil KS, Chakrabarty S, Kuchi VS. Influence of postharvest treatments on quality of loose flowers of *Polianthes tuberosa* Linn. cv. Prajwal. Int. J Curr. Microbiol. App. Sci. 2017;6:440-448.
18. Suisuwan NC. Improvement of postharvest method of jasmine flower buds, precooling, In AGRIS; c1994. p. 41.
19. Talukdar MC, Barooah L. Effect of pulsing and different holdingsolutions on flower quality and vase life of tuberose (*polianthes tuberose* L) cv. 'Calcutta Double'. Indian J Hill Farming. 2011;24:31-33.
20. Wills R, Mc Glasson B, Graham D, Joyce D. An introduction to the physiology and handling of fruit, vegetables and ornamentals. UNSW Press. Desiccation trial CATIE: The seeds were desiccated to. 1998;26(21.3):10-5.