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Response of *Jasminum auriculatum* ecotype Pacha Mullai flowers to post-harvest treatments

Kancharla Sunny, M Ganga, M Visalakshi and M Suganthy

Abstract
An experiment was conducted at Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore to examine the impact of post-harvest treatments to improve the shelf life of *Jasminum auriculatum* ecotype Pacha Mullai. Six treatments replicated four times in Completely Randomized Design (CRD) with two storage conditions namely room temperature and refrigeration, two floral preservatives namely Sucrose and Boric Acid along with an untreated control. Observations were recorded on the flower visual quality parameters and the physiological parameters associated with the postharvest quality of flowers. According to the study, flower buds treated with 4 percent boric acid and kept in a refrigerator at 5 °C had a much longer shelf life of 177.85 hours (T_6), (against 64.97 hrs in untreated control, T_1). This treatment also proved to be superior to the other postharvest parameters *viz.*, highest freshness index (82.52%), fragrance score (3), colour retention index (83.97%), moisture content (46.97%), relative water content (53.09%), lowest flower opening index (8.09%), physiological weight loss (4.64%), solute leakage (77.48%), highest membrane integrity and total carbohydrate content (56.59 percent) on the sixth day after packing.

Keywords: Boric acid, floral preservatives, *Jasminum auriculatum*, physiological parameters, postharvest sucrose, visual quality parameters

1. Introduction
The most commercially significant loose flowers grown in India include jasmine, marigold, aster, tuberose, chrysanthemum, and crossandra. Owing to their graceful blossoms, rich fragrance, numerous aesthetic benefits, high exportable potential, and ability to bring in more profits for flower producers, jasmines occupy an exceptional place among the various flowers. Jasmine belongs to the family Oleaceae. The genus *Jasminum* comprises around 200 species which are dispersed throughout warmer parts of Europe, Asia, Africa, the Pacific region, and many other tropical and subtropical countries. About 40 species are native to India (Bhattacharjee SK, 1980) [1].

Jasmines contribute significantly to the national economy. Tamil Nadu is the leading state in India for the production and export of jasmine flowers. *J. auriculatum* is one of the most important species of jasmine in India. The flowers are used for many different purposes, such as making garlands and bouquets, offering them in religious ceremonies, etc. In the cosmetic and perfumery industry, essential oils like, concrete and absolute are produced from these jasmine flowers. Due to their attractive fragrance, these blooms are in high demand for export.

J. auriculatum blooms are extremely delicate; 24 to 36 hours after being harvested, they begin to wilt and distinctively lose their aroma. Currently, jasmine flowers are lacking more advanced techniques besides those traditional technologies are using for harvesting, packing, storing, marketing and transporting which are required for the fresh bloom trade. Jasmine blooms typically do not last for more than a day and, on the second day after picking, they will show signs of browning or wilting of petals, loosing fragrance when kept under room temperature. Krishnamoorthy S, (1990) [2] reported that packing is a key component of post-harvest management for highly perishable commodities, and effective packaging prolongs the shelf life of produce by preventing physical, physiological, and pathological degradation during transporting and marketing.

There will be an annual savings of 100-200 crores of rupees in India if the waste of horticulture produce from the production centres to the market is reduced by even 2% (Ramana *et al.*, 1988) [3]. Because floral physiology is highly complicated, researchers frequently concentrate primarily on changes that take place at the time of senescence of petals rather than necessarily the longevity of flowers. Desai *et al.*, 2012 [4] examined the storage life

of *J. sambac* and came to the conclusion that the flower buds can be kept fresh for 6 days at 7.2°C. According to Karuppaiah *et al.,* (2006) [5] research, *J. sambac* flowers can have their post-harvest life extended up to 81 hours by being packed in 200-gauge polyethylene bags without ventilation.

2. Materials and methods

2.1. Study site and design of experiment

The present study was carried out at Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during the year 2021-22. For the investigation, fresh, unopened flower buds of the same size from the *J. auriculatum* ecotype Pacha Mullai plants were employed. Six treatments and four replications were used in the experiments, which were set up in Completely Randomized Design (CRD).

2.2. Treatment details

The treatments included storing flower buds at room temperature (T_1 Control), storing flower buds under refrigeration at 5°C (T_2), treating flower buds with 4 percent sucrose and storing them at room temperature (T_3), treating flower buds with 4 percent sucrose and refrigeration at 5°C (T_4), treating flower buds with 4 percent boric acid and storing them at room temperature (T_5), and treating flower buds with 4 percent boric acid + refrigeration at 5°C (T_6).A total of 100 fresh flower buds of the same size were treated with 4 percent Sucrose and Boric acid respectively, then surface dried. After that polyethylene bags with 15 cm × 10 cm in size, 200-gauge micron thickness were taken and the flower buds was packed in polyethylene bags, and heat sealed. As advised by Bose and Raghava in 1975 [6], the cold room's temperature and relative humidity were set at 5°C and 80–85%, respectively.

2.3. Parameters

Based on hedonic scale scoring given by Madhu 1999 [7], the flower quality parameters including freshness index, colour retention index, flower opening index, fragrance score (least and undesirable - 1, mild - 2, strong - 3, very strong - 4), and shelf life were recorded. Moisture content (MC), relative water content (RWC), physiological loss in weight (PLW), membrane integrity (MI), and total carbohydrate content are physiological measures that are calculated in accordance with Barrs and Weatherley, 1962 [8]. All the data was recorded on the second, fourth, and sixth days after treatment. Statistical analysis carried out in this study was performed by using the statistical package 'TNAUSTAT'.

3. Results and Discussion

3.1. Visual quality parameters for flower buds of *J. auriculatum* ecotype Pacha Mullai

3.1.1. Freshness index and flower opening index

It could be observed from Table.1 that the freshness index values ranged from 77.94 to 98.03 with a mean value of 88.91 at two days after packing (Table 1). The highest freshness index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). At four days after packing, freshness index values ranged from 54.25 to 93.13 with a mean value of 77.89. The highest freshness index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration 5^0C) and the lowest value was recorded under T_1 (Control). After six days, freshness index values ranged from 32.17 to 82.52 with a mean value of 60.12. The highest freshness index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). Maximum carbohydrate buildup and an increase in peroxidase and catalase activity of three to six times each. Due to enhanced membrane integrity, this in turn decreased solute leakage from flowers was observed. All of these elements showed effective in maintaining the freshness index of flowers and delayed wilting. The osmotic concentration and pressure potential of the flower petal cells might be increased by the boric acid which is used as a mineral salt previously, that have been improved the water balance and vase life of cut flowers Halevy, 1976 [9], Vanmeeteren, 1989 [10].

It could be observed from Table.1 that the flower opening index values ranged from 26.96 to 1.67 with a mean value of 11.32 at two days after packing. The highest flower opening index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). At four days after packing, the freshness index values ranged from 50.25 to 4.24 with a mean value of 20.05. The highest flower opening index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). After six days, flower opening index values ranged from 32.17 to 82.52 with a mean value of 60.12. The highest freshness index value was recorded under T_6 (Boric acid 4% + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control).

Table 1: Impact of post-harvest treatments on freshness index and flower opening index of *J. auriculatum* ecotype Pacha Mullai flower buds

Treatments		Freshness index (%)			Flower opening index (%)		
		Days after packing			Days after packing		
		2	4	6	2	4	6
T_1	Storage at room temperature (Control)	77.94	54.25	32.17	26.96	50.09	73.29
T_2	Storage under refrigeration @ 5^0C	92.89	79.8	66.84	5.15	12.44	23.63
T_3	Sucrose 4 % + Room temperature	82.02	78.75	45.93	18.65	21.62	63.72
T_4	Sucrose 4% + Refrigeration @5^0C	94.8	88.45	79.84	2.98	7.18	12.98
T_5	Boric acid 4 % + Room temperature	87.79	72.97	53.42	12.53	24.78	52.7
T_6	Boric acid 4% + Refrigeration @ 5^0C	98.03	93.13	82.52	1.67	4.24	8.09
Mean		88.91	77.89	60.12	11.32	20.05	39.06
SEd		1.37	1.55	1.56	0.26	1.03	1.34
CD (0.05)		2.88	3.26	3.28	0.54	2.17	2.82

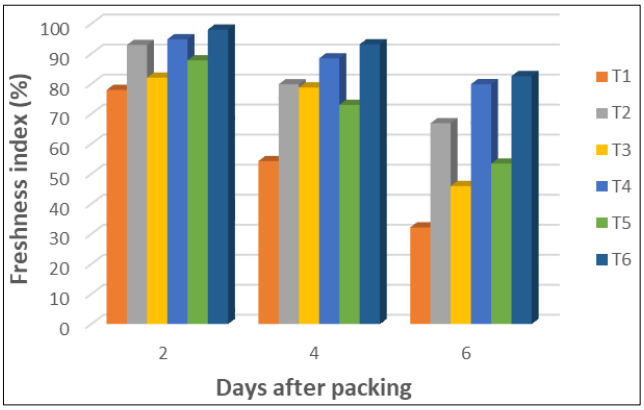

Fig 1

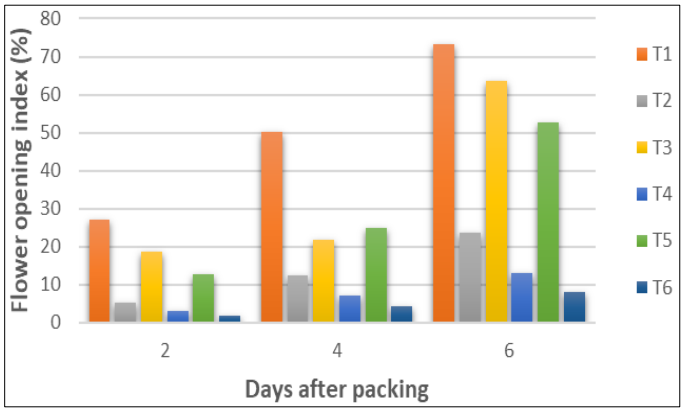

Fig 2

Fig 1, 2: Impact of post-harvest treatments on freshness index and flower opening index of *J. auriculatum* ecotype Pacha Mullai flower buds

3.1.2. Colour retention index, Fragrance score and Shelf life

It could be observed from Table 2. that the colour retention index values ranged from 67.90 to 98.36 with a mean value of 85.30 at two days after packing. The highest colour retention index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). At 4 days after packing, the colour retention index values ranged from 52.67 to 92.88 with a mean value of 72.96. The highest colour retention index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). After 6 days, colour retention index values ranged from 33.02 to 83.97 with a mean value of 62.09. The colour retention freshness index value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). It was found that the boric acid-treated flowers exhibited typical colour retention and aroma and less phenol buildup than the control. The potential for boric acid to prolong the life of flowers after harvest has already been reported in jasmine by (Mukhopadhyay *et.al*, 1980, Jawaharlal *et.al*, 2012, Manimaran *et.al*, 2018, Sushree Choudhury *et.al*, 2020) [11, 12, 13, 14] and in crossandra by Bhattacharjee, (2002) [15] which is consistent with the present finding.

It could be observed from Table 2. that the fragrance score values ranged from (3, 1, 1), to (2, 3, 3) with mean values of (2.16, 2.33, 2.16) at 2, 4, 6 days after packing respectively. The highest fragrance score values were recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest values was recorded under T_1 (Control)

Similarly, from Table 2. The shelf life of the flower buds with different treatments varies from 64.97 hrs. to 177.85 hrs. The longest shelf life was observed in T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). Senescence causes the changes in flowers moisture content, carbohydrate and other nutritional reserves, enzyme activity, and ethylene production and action were frequently observed. Water loss is the primary factor, preventing the post-harvest life of the flowers. Water stress is the main factor that reduces shelf life of flowers. Decreasing the rate of water loss mostly depends on preserving at high relative humidity (90-98 percent), either through the use of packaging or by keeping the flowers at a low temperature Wills *et al.*, 1998[16]. The accumulation of flavins and other phenolic chemicals in flower cell vacuoles may be the reason for the browning and loss of fragrance as reported by (Burzo *et al.*, 1988) [17].

Table 2: Impact of post-harvest treatments on colour retention index, fragrance score and shelf life of *J. auriculatum* ecotype Pacha Mullai flower buds

Treatments		Colour retention index (%)			Fragrance score			Shelf life (hours)
		Days after packing			Days after packing			
		2	4	6	2	4	6	
T_1	Storage at room temperature (Control)	67.90	52.67	33.02	3	1	1	64.97
T_2	Storage under refrigeration @ 5^0C	91.95	82.18	71.77	2	3	3	143.83
T_3	Sucrose 4 % + Room temperature	76.21	56.01	49.05	2	2	2	85.38
T_4	Sucrose - 4% + Refrigeration @ 5^0C	95.59	86.52	78.64	2	3	3	158.49
T_5	Boric acid 4 % + Room temperature	81.81	68.51	56.13	2	2	1	93.21
T_6	Boric acid 4% + Refrigeration @ 5^0C	98.36	92.88	83.97	2	3	3	177.85
Mean		85.30	72.96	62.09	2.16	2.33	2.16	120.62
SEd		0.91	1.20	1.46	0.03	0.03	0.02	2.12
CD (0.05)		1.91	2.54	3.07	0.07	0.07	0.06	4.46

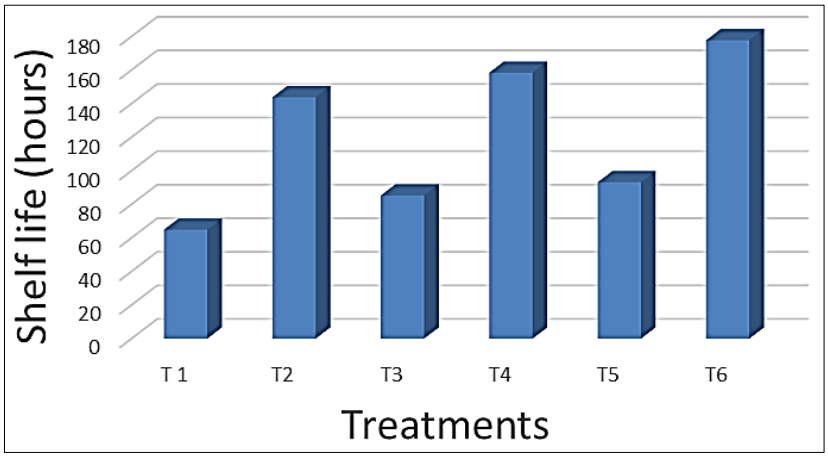

Fig 3: Impact of post-harvest treatments on shelf life of *J. auriculatum* ecotype Pacha Mullai flower buds

3.2. Physiological parameters for flower buds of *J. auriculatum* ecotype Pacha Mullai

3.2.1 Moisture content and Relative water content

As observed from Table 3, the moisture content values ranged from 51.55 to 79.90 with a mean value of 66.34 at 2 days after packing. The highest moisture content value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5^0C) and the lowest value was recorded under T_1 (Control). At 4 days after packing, moisture content values ranged from 24.85 to 64.31 with a mean value of 44.03. The highest moisture content value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the lowest value was recorded under T_1 (Control). After 6 days, moisture content values ranged from 7.09 to 46.97 with a mean value of 23.73. The highest moisture content value was recorded under T_6 (Boric acid 4% + stored under refrigeration @ 5 ^{0}C) and the lowest value was recorded under T_1 (Control).

As observed from Table 3, the relative water content values ranged from 52.34 to 75.58 with a mean value of 64.43 at 2 days after packing. The highest relative water content value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the lowest value was recorded under T_1 (control). At 4 days after packing, the relative water content values ranged from 37.64 to 65.48 with a mean value of 51.95. The highest relative water content value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the lowest value was recorded under T_1 (Control). After 6 days, Relative water content values ranged from 21.77 to 53.09 with a mean value of 39.21. The highest relative water content value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the lowest value was recorded under T_1 (Control). As observed by Nichols, 1966 [18] in carnation and Sharma, 1981 [19] in *Rosa damascena*, that increased PLW causes a drop in the fresh weight of flowers, which manifests visibly as signs of wilting of blooms. The water status of petals is expressed by the relative water content of flowers. It is evident that relative water content remains high when moisture content is higher and weight loss is lower.

Table 3: Impact of post-harvest treatments on moisture content, relative water content of *J. auriculatum* flowers ecotype Pacha Mullai flower buds.

Treatments		Moisture content (%)			Relative water content (%)		
		Days after packing			Days after packing		
		2	4	6	2	4	6
T_1	Storage at room temperature (Control)	51.55	24.87	7.09	52.34	37.64	21.77
T_2	Storage under refrigeration @ 5^0C	72.35	48.77	28.07	69.83	57.46	45.00
T_3	Sucrose 4 % + Room temperature	56.31	31.36	9.48	56.10	42.29	31.41
T_4	Sucrose - 4% + Refrigeration @ 5^0C	75.11	57.11	39.66	71.86	60.90	48.26
T_5	Boric acid 4 % + Room temperature	62.86	37.78	11.11	60.91	47.95	35.78
T_6	Boric acid 4% + Refrigeration @ 5^0C	79.90	64.31	46.97	75.58	65.48	53.09
Mean		66.34	44.03	23.73	64.43	51.95	39.21
SEd		1.2150	0.45	0.21	1.06	0.65	0.48
CD (0.05)		2.5526	0.94	0.44	2.23	1.37	1.01

3.2.2 Physiological loss in weight, solute leakage and total carbohydrates content

As observed from Table 4, the physiological loss in weight values ranged from 4.80 to 1.50 with a mean value of 3.02 at 2 days after packing. The lowest physiological loss in weight value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the highest value was recorded under T_1 (Control). At 4 days after packing, the physiological loss in weight values ranged from 7.11 to 2.88 with a mean value of 4.73. The lowest physiological loss in weight value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the highest value was recorded under T_1 (Control). After 6 days, the physiological loss in weight values ranged from 11.28 to 4.64 with a mean value of 7.48. The lowest physiological loss in weight value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the highest value was recorded under T_1 (Control).

As observed from Table 4, the solute leakage values ranged from 68.95 to 53.27 with a mean value of 62.02 at 2 days after packing. The lowest solute leakage value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C)

and the highest value was recorded under T_1 (control). At 4 days after packing, solute leakage values ranged from 89.01 to 65.35 with a mean value of 77.19. The lowest solute leakage value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the highest value was recorded under T_1 (Control). After 6 days, solute leakage values ranged from 97.11 to 77.48 with a mean value of 88.80. The lowest solute leakage value was recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the highest value was recorded under T_1 (Control). Treatment T_6 (Boric acid 4 percent + Stored under refrigeration @ 5 ^{0}C) showed the lowest solute leakage and, consequently, the maximum membrane integrity, besides that T_1 (Control) showed the highest solute leakage and consequently (lowest membrane integrity) on the second, fourth, and sixth days after packing.

As observed from Table 4, the total carbohydrate content values ranged from (56.23, 35.24, 16.43) to (92.39, 75.99, 56.59) with mean values of (73.47, 56.82, 36.99) at 2, 4 and 6 days after packing respectively. The highest total carbohydrates content values were recorded under T_6 (Boric acid 4 percent + stored under refrigeration @ 5 ^{0}C) and the lowest values was recorded under T_1 (Control). The presence of carbohydrates has a substantial impact on the vase life of cut flowers, and the breakdown of sugars is a major factor associated with ageing, was reported by Kazemi *et al.* (2011) [20]. Both lifespan of the vase and fresh weight loss, might be increased by reducing the activity of ACC synthase and ACC oxidase. These results are in line with studies on cut roses conducted by Hoseinzadeh Liavali and Zarchini, 2012 [21] and Ezhilmathi *et al.*, 2007 [22].

Table 4: Impact of post-harvest treatments on physiological loss in weight, solute leakage and total carbohydrates (mg g-1) of *J. auriculatum* flowers ecotype Pacha Mullai flower buds.

Treatments		Physiological loss in weight (%)			Solute leakage (%)			Total carbohydrates (mg g^{-1})		
		Days after packing			Days after packing			Days after packing		
		2	4	6	2	4	6	2	4	6
T_1	Storage at room temperature (Control)	4.8	7.11	11.28	68.95	89.01	97.11	56.25	35.24	16.43
T_2	Storage under refrigeration @ 5^{0}C	2.42	3.63	6.83	58.84	72.84	85.96	76.05	61.99	42.49
T_3	Sucrose 4 % + Room temperature	3.96	6.55	9.13	68.4	86.32	95.97	61.19	46.24	51.49
T_4	Sucrose - 4% + Refrigeration @ 5^{0}C	1.93	3.09	5.78	55.19	69.42	82.5	90.99	72.49	24.89
T_5	Boric acid 4 % + Room temperature	3.56	5.13	7.23	67.5	80.23	93.78	63.96	48.99	30.1
T_6	Boric acid 4% + Refrigeration @ 5^{0}C	1.5	2.88	4.64	53.27	65.35	77.48	92.39	75.99	56.59
Mean		3.02	4.73	7.48	62.02	77.19	88.80	73.47	56.82	36.99
SEd		0.04	0.10	0.11	0.90	1.40	1.53	2.06	1.31	0.58
CD (0.05)		0.08	0.22	0.24	1.89	2.96	3.22	4.34	2.75	1.22

4. Conclusion

The present investigation which was carried out to standardize the post-harvest treatments to extend the shelf life of *J. auriculatum* ecotype Pacha Mullai led to the inference that the post-harvest treatment of flower buds with 4% boric acid and storage under refrigeration @ 5^{0}C proved effective in prolonging the post-harvest shelf life and retaining quality of the flowers. This was followed by treatment with 4 % sucrose and storage under refrigeration @ 5^{0}C which also recorded better results with respect to shelf life and quality retention.

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6. References

1. Bhattacharjee SK. Native jasmines of India, Indian Perfumer. 1980;24:126-33.
2. Krishnamoorthy S. Packaging of horticultural crops. Packaging India, 1990, 7-20.
3. Ramana KV, Rodoviguez R, Rao V. Packaging of fresh fruits and vegetables. Ibid, 1988, 31-38
4. Desai R, Patel R, Mankad A. Petal senescence in cut *Tagetes erecta* L. flowers: Role of phenolics, International Journal of Science, Environment and Technology. 2012;1(5):485–490.
5. Karuppaiah P, Ramesh Kumar S, Rajkumar M. Effect of different packages on the post-harvest behaviour and shelf life of jasmine (*Jasminum sambac*), International Journal of Agricultural Sciences. 2006;2(2):447-449.
6. Bose TK, Raghava SPS. Low temperature prolongs the storage life of jasmine flower, Science and Culture. 1975;41:115-116.
7. Madhu GR. Studies on the effect of different packaging materials and chemicals on the post-harvest life of Jasmine flowers, M.Sc. (Ag.) thesis submitted to Annamalai University, Annamalai Nagar, Tamil Nadu, 1999.
8. Barrs HD, Weatherley PE. A re-examination of the relative turgidity technique for estimating water deficit in leaves, Austr. J. Biol. Sci. 1962;15:413-428.
9. Halevy AH. Treatments to improve water balance of cut flowers, Acta Hort. 1976;64:223-230.
10. Van Meeteren U. Water relations and early leaf wilting of cut chrysanthemums, Acta Hort. 1989;261:129-135
11. Mukhopadhyay TP, Bose TK, Maiti RG, Misra SK, Biswas J. Effect of chemicals on the post-harvest life of jasmine flowers. National Seminar on Production Technology of Commercial Flower Crops. Tamil Nadu Agricultural University, Coimbatore, 1980, 47-50.
12. Jawaharlal M, Thamaraiselvi SP, Ganga M. Packaging technology for export of jasmine (*Jasminum sambac* Ait.) flowers J. Hortl. Sci. 2012;7(2):180-189
13. Manimaran P, Ganga M, Kannan M, Arulmozhiselvan K. Standardization of post-harvest management techniques for *Jasminum nitidum* flowers. Chemical Science Review and Letters. 2018;7(26):652-658
14. Sushree Choudhury Jatindra Nath Das, Chitta Ranjan

Mohanty, Bijaya Kumar Mishra, Arun Kumar Das. Influence of postharvest treatments on quality and shelf life of flowers of *Jasminum sambac* cv. Gundumalli, International Journal of Chemical Studies, IJCS. 2020;8(2):598-602.
15. Bhattacharjee SK. Post-harvest management of flowers. In: Handbook of Horticulture. (ed.), Chadha, K.L. New Delhi, ICAR publications, 2002.
16. Wills R, Mc Glasson B, Graham D, Joyce D. Postharvest: An Introduction to the Physiology and Handling of Fruit, Vegetables and Ornamental, 1998, 4th d. UNSW press, Sydney.
17. Burzo I, Amariute A, Cracium C, Cachita D. Changes in the potential difference across membranes and ultrastructure of Gladiolus flowers preserved in water at room temperature. Fourth international symposium on Post-harvest Physiology of Ornamental Plants, 1988, 119-127
18. Nichols R. Ethylene production during senescence of flowers. J. Hort. Sci. 1966;41:279-290.
19. Sharma V. Biochemical changes accompanying petal development in *Rosa damascene*, Plant Biochemical J. 1981;8(1):13-16.
20. Kazemi M, Zamani S, Aran M. Am. J. Plant Physiol. 2011;2:99-105.
21. Hoseinzadeh Liavali MB, Zarchini M. J. Ornament. Hortic. Plants. 2012;2(2):123-130.
22. Ezhilmati KV, Singh P, Arora A, Sairam RK. Plant Growth Regul. 2007;51:99-108.