Full Length Research Article

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Research Journal of Agricultural Sciences
Volume 15; Issue 03 (May–Jun 2024); pp 656–660

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Extending the Shelf Life and Quality of Jasmine (*Jasminum sambac*) Through Different Chemical Treatments

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Received: 28 Feb 2024; Revised accepted: 16 Apr 2024

Abstract

Jasminum sambac, one of the most significant commercial flower crops, is extensively grown in India and is prized for its fragrant, eye-catching blooms. Because of their lovely aroma, these flowers are in high demand for export. However, one of the biggest issues farmers deal with is the shelf life of flower buds, which results in browning of petals and an abrupt loss of aroma on the second day of harvest. The present experiment was laid out in a CRD with 11 treatments and 3 replications. The chemical treatments like T_1 (Benzyladeninepurine -100ppm), T_2 (Benzyladeninepurine -200ppm), T_3 (Kinetin -100ppm), T_4 (Kinetin -200ppm), T_5 (Boric acid-2%), T_6 (Boric acid-4%), T_7 (Salicyclic acid-25ppm), T_8 (Salicyclic acid-50ppm), T_9 (Sodium benzoate-25ppm), T_{10} (Sodium benzoate-50ppm) and T_{11} (Control). Among the different chemical treatments, the Jasminum flower buds treated with boric acid (2%) retained the maximum freshness index (74.79%), color retention index (60.86%), moisture content (67.66%), fragrance index (3.87), and shelf life (57.92 hours). The minimum physiological loss in weight (9.15%), total phenol content (6.41 mg/g), flower opening index (33.66), and browning index (32.41). The experiment's findings indicated that treating jasmine flower buds with 2% boric acid extended the flower bud quality and shelf life.

***Key words*:** Jasmine, Boric acid, Color retention index, Freshness, Shelf life, Flower quality

A flower is the symbol of beauty, love, and tranquility. A flower conveys the message of love and joy. Flowers are used by people to express their first feelings for each other. In Flowers have been one of the main ingredients for beautification since the beginning of history. Among the commercial flowers grown in India; the most important are roses, carnations, gerberas, orchids, chrysanthemum, jasmine, marigold, aster, etc. Among the different kinds of flowers, jasmine take the uninumero position because of their elegant stars, attractive flowers, rich fragrance, multifaceted aesthetic utilities, high exportable value, and earning lucrative income for the flower growers. Jasmine is highly valued in India and is considered one of the most ancient and fragrant flowers [1]. Jasmine is a Persian word, "Yasmin," which means "fragrance.". It is extensively cultivated in warm regions of southern Asia, Europe, Africa, and the Pacific. Numerous soil types and climates are suitable for growing jasmine. For development and flowering, it typically favors a mid-tropical environment. *Jasminum sambac*, also known as Motia or Lily Jasmine, is a scandent or sub-erect shrub that is grown almost everywhere in the world's tropical and sub-tropical regions. It has young pubescent branches, opposite leaves that are broadly ovate or elliptic, and white, extremely fragrant flowers [2].

The state exports its flowers to its neighbors, including Malaysia, Singapore, Sri Lanka, and nations in the Middle East. In Tamil Nadu, Dindigul, Salem, Madurai, Tirunelveli, Virudhunagar, and Trichy are the principal jasmine-producing districts. Tirunelveli district holds the top spot [3]. After being harvested, flowers continue to live and undergo metabolic processes that lead to the depletion of carbohydrates, an increase in temperature and respiration rates, rapid deterioration from microorganisms, water stress, and an increased build-up of ethylene. Harvested product deteriorates due to all of the aforementioned variables, hence post-harvest handling techniques are necessary. After harvest, the product should be handled carefully to prevent physical damage like bruising and moisture loss, as well as to slow down unwanted chemical changes and delay spoiling.

Cytokinins are a hormone of choice for prolonging the postharvest performance of different cut flowers because of their inhibitory effect on bloom senescence. Salicylic acid is a member of the phenolic chemical family. This substance is frequently found in plants. According to Hayat *et al.* [4], salicylic acid may be regarded as an endogenous plant growth regulator that controls plant development, growth, and disease resistance mechanisms. Additionally, it has been discovered that salicylic acid reduces ROS (reactive oxygen species) by raising antioxidant enzymes and suppressing the activity of ACC-oxidase, which is the direct precursor of ethylene. According to [5-6], this method is very successful at reducing

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Citation: Marappan K, Khanchana K, Arumugam VA. 2024. Extending the shelf life and quality of jasmine (*Jasminum sambac*) through different chemical treatments. *Res. Jr. Agril. Sci.* 15(3): 656-660.

anthocyanin pigment loss, stem bending, flower withering, and fresh weight loss. According to reports, boric acid has chemical characteristics that prolong the vase life of cut carnations by preventing the first spike in ethylene production. More floret diameter retention, floret weight retention, relative water content, and membrance stability index were obtained by treating florets in a 200-ppm boric acid solution. [7] documented 4 percent boric acid treatment of flower buds' results in increased physiological weight loss, lowest flower opening index, greatest freshness index, aroma score, color retention index, moisture content, and relative water content. Application of benzolaminopurine postponed flower senescence by lowering the generation of abscisic acid, which is known to increase in both ethylene-sensitive and insensitive flowers during flower senescence. Sodium benzoate has a positive influence on flowers' vase life and exhibits anti-ethylene activity; it may be a senescence inhibitor. Because of its antibacterial qualities, sodium benzoate may be the reason why flowers' vase lives are prolonged. vase life, fresh weight loss, ethylene production, Brix index, SPAD value, bacterial population in vase solution, flower opening index, and protein content after flowers treated with 250 mg/l of sodium benzoate [8]. According to research conducted by [9], flowers treated with 50 ppm sodium benzoate had the longest shelf life, the least amount of fresh weight loss, and the largest percentage of fresh flowers that were more palatable.

MATERIALS AND METHODS

The investigation on extending the shelf life and quality of jasmine (*Jasminum sambac*) through different chemical treatments was carried out in the floriculture laboratory, Department of Horticulture, APHC, Kalavai, Ranipet district, during 2022-2023. The present experiment was laid out in a completely randomized design (CRD) with 11 treatments and 3 replications. The chemical treatments like T_1 (benzyladenine purine, 100 ppm), T_2 (benzyladenine purine, 200 ppm), T_3 (kinetin, 100 ppm), T_4 (kinetin, 200 ppm), T_5 (boric acid, 2%), T_6 (boric acid, 4%), T_7 (salicyclic acid, 25 ppm), T_8 (salicyclic acid, 50 ppm), T_9 (sodium benzoate, 25 ppm), T_{10} (sodium benzoate, 50 ppm), and T_{11} (control). Ten grams of freshly harvested flowers were treated with varying chemical concentrations before being shaded to eliminate extra moisture.

Observations recorded

Physiological loss in weight (PLW) (%)

The PLW (%) of whole flowers was calculated from the mean of the replicated flower packages using the following formula:

$$\text{PLW} = \left(\frac{\text{Fresh weight (day I) - Weight (day II)}}{\text{Fresh weight (day I)}}\right) \times 100$$

Moisture content (MC) (%)

The moisture content of the flower bud was assessed after recording the fresh weight and dry weight of flower buds (kept in hot air oven at 70 °C). Moisture content was expressed in fresh weight basis in percentage and was calculated from the following formula:

$$\text{Moisture content \%} = \left(\frac{\text{Fresh weight - dry weight}}{\text{Fresh weight}}\right) \times 100$$

Freshness index (FI)

The following score was used to visually observe the number of flowers that maintained their freshness without showing signs of petal necrosis, wilting, or browning. The results were expressed as a percentage of fresh flowers or a freshness index.

Condition of flowers	Score	Number of flower buds
Almost all buds turgid	7	X_1
Partial to half open flowers, turgid	6	X_2
Half to full open flowers, turgid	5	X_3
Partial to half open flowers, slightly wilted	4	X_4
Half to full open flowers, slightly wilted	3	X_5
Partial to half open flowers, fully wilted	2	X_6
Half to full open flowers fully wilted	1	X_7

Freshness index (FI) was computed using the following formula:

$$\text{FI} = \left(\frac{(7 \text{ x } X_1) + (6 \text{ x } X_2) + (5 \text{ x } X_3) + (4 \text{ x } X_4) + (3 \text{ x } X_5) + (2 \text{ x } X_6) + (1 \text{ x } X_7)}{(X_1+X_2+X_3+X_4) \text{ x } 7}\right) \times 100$$

Flower opening index (FOI)

The flower opening index was measured by using following score.

Stage of flowers	Score	Number of flower buds
Unopened buds	0	X_1
Slightly opened	1	X_2
Half opened	2	X_3
Full opened	3	X_4

Flower opening index (FOI) was computed using the following formula:

$$\text{FOI} = \left(\frac{(0 \text{ x } X_1) + (1 \text{ x } X_2) + (2 \text{ x } X_3) + (3 \text{ x } X_4)}{(X_1 + X_2 + X_3 + X_4) \text{ x } 4}\right) \times 100$$

Colour rétention index (CRI)

The retention of pink colour of jasmine flower buds was recorded by the following score:

Flower bud colour development during storage	Score	Number of flower buds
Bright pink	9	X_1
Dull pink	8	X_2
Cream or yellowish	7	X_3
1 to 10% brown	6	X_4
11 to 15% brown	5	X_5
16 to 50% brown	4	X_6
51 to 75% brown	3	X_7
76 to 90% brown	2	X_8
All brown	1	X_9

Colour retention index (CRI) was computed by using the following formula:

$$CRI = \left(\frac{(9 \times X_1)+(8 \times X_2)+(7 \times X_3)+(6 \times X_4)+(5 \times X_5)+(4 \times X_6) +(3 \times X_7)\ (2 \times X_8)+(1 \times X_9)}{(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_9) \times 9} \right) \times 100$$

Fragrance index

The fragrance released by the flowers was computed based on the following score

Fragrance level	Ranking
Least and undesirable	1
Mild	2
Strong	3
Very strong	4

Total phenolic content (mg g $^{-1}$)

Using 80% ethanol, phenols were extracted, dried, and the amount of blue color developed by the FC (folin-ciocalteau) reagent was detected at 690 nm. The result was represented as µg of pyro-catechol equivalent per g of material.

Shelp life

Flower shelf life was determined by counting the number of days that at least 50% of the flowers (or 50% of the freshness index score) stayed fresh without deteriorating in a pink or brown manner [10] The results were statistically analyzed by the application of [11] methodology.

RESULTS AND DISCUSSION

Physiological loss in weight (PLW) (%)

The minimum physiological loss in weight was observed when the flower buds treated with Boric acid-2% showed a minimum physiological loss of 9.15% and maximum physiological loss was observed in control 12.65%. The main factor limiting the postharvest physiology of flower buds by exacerbating senescence is water loss. The water status of the flower bud controls physiological elements like moisture content, RWC, and membrane integrity, all of which have an impact on the flower's appearance in terms of freshness, flower opening, and bud color. The overall fresh weight of the flowers eventually decreased as a result of the higher physiological loss in weight (PLW). Visually, this decline showed itself as wilting and other signs of senescence. The water state of the flower petals is indicated by the relative water content of the flower bud. It goes without saying that weight loss will be lessened if moisture content is maintained. Previous research on Gerbera has shown a similar falling tendency in fresh weight with rapid weight loss after senescence. The flowers were able to stay fresh for an extended period of time because of the delay in protein degradation and decrease in transpiration caused by the application of boric acid. In *Jasminum sambac*, a similar trend has been reported by [11-12].

Moisture content (%)

The moisture content of jasmine buds was significantly affected by the different post-harvest chemical treatments (Table 1). The buds treated with 2% boric acid had a maximum moisture content of 67.66%. This could be because the boric acid-treated flower buds decreased the amount of water lost through transpiration by delaying senescence. The turgidity of the cells and the water content of the petals will both be sustained throughout the storage period. The findings are in accordance with the report of [14] on Gladiolus. The minimum flower bud moisture content was observed in the untreated control at 35.85%. The flower buds under control exhibited more water loss, which may have resulted from higher rates of respiration in the hot weather. Flower senescence in Rosa hybrids was shown to be primarily caused by a sharp decrease in the moisture content of the flower bud [15].

Total phenol content (mg/g)

The data on total phenol content influenced by different chemical treatments is given in Table 1. The minimum phenol content was observed when the flower buds were treated with 2% boric acid at 6.41%, and the maximum production of phenol was noticed in control at 9.32%. This could be the result of biochemical alterations brought on by the administration of chemicals, which may have preserved the cell's structure and membrane integrity, reducing catabolic processes and quality losses [16]. As the phases advanced, there was a rising tendency in the total quantity of phenols. Throughout the storage period, the jasmine flower bud's total phenolic content rises quickly. This increased phenol content may have produced an internal environment that was conducive to the alterations associated with flower senescence [17].

Freshness index (FI)

The data on the effect of post-harvest chemical treatment on the freshness index of jasmine flowers is given in (Table 1). Among the various treatments, the flowers treated with 2% boric acid showed the highest freshness index of 74.79% and the minimum in control (42.19%). This may be due to the enhanced freshness of flower buds in 2% boric acid, which may have been attributed to a delayed senescence, which lowers ethylene biosynthesis and prolongs the lifespan of plant organs. Decreased metabolic activity rate, which lowers transpiration and the loss of food resources from storage through low respiration [18-19].

Colour retention index (CRI)

The flower bud's color retention index falls as polyphenol oxidase activity rises. The activity of polyphenols is decreased when flower buds are treated with 2% boric acid, which lowers the phenol content while increasing the color retention index, while untreated flower buds (control) show a lower color retention index of 32.51%. This explains the polyphenol oxidase activity causes enzymatic discoloration by oxidizing phenol molecules, which results in the browning of petals during senescence [20].

Flower opening index

The flower opening index of jasmine blossom was significantly impacted by various post-harvest treatments is presented in (Table 1). The bud treated with boric acid 2% + showed minimum flower bud opening index of 33.66% and control showed maximum flower opening index of 62.08%. The minimum flower opening index in a 2% boric acid treatment may be due to the maximum moisture content and minimum physiological losses. The maximum due to more respiration in untreated flower buds resulted in less moisture content and high physiological losses, which in turn increased the flower opening index.

Fragrance index

It was discovered that flower buds treated with 2% boric acid resulted in a maximum fragrance index (3.87%) compared to untreated buds (1.94%). Maximum fragrance could be a result of the flower buds' freshness, which preserved the fragrance components. Minimum fragrance index: because more phenolic chemicals accumulated in untreated flower buds, there was less odor blossom and a lower fragrance index [21].

Browning index (BI)

The data pertaining to the browning index of jasmine flower buds treated with different chemical treatments is presented in (Table 1). The minimum browning index was observed in boric acid 2% treated flower buds and maximum browning index was noticed in control. The maximum browning may be due to the production of more phenol content in the cells of flowers, which turn the petals brown. The same report was also published in *Jasminum sambac* [22].

Shelf life

Flower buds treated with 2% boric acid had the longest shelf life of 57.92 hours and the minimum in control of 24.45 hours. Flower buds' shelf life was extended by the beneficial impacts of physiological and visual characteristics without compromising their quality, color, or fragrance by the boric acid treatment [23-25]. Boric acid holds promise as a valuable tool for enhancing the post-harvest lifespan of flowers, contributing to improved marketability and customer satisfaction.

Table 1 Different Chemical Treatments on Shelf Life and Quality of Jasmine (*Jasminum sambac*)

Treatments	Physiological loss in weight (%)	Moisture content (%)	Total phenol content (mg/g)	Freshness Index (FI) (%)	Colour retention index (CRI)	Flower opening index (%)	Fragrance index (%)	Browning index (%)	Shelf life (Hours)
T_1	9.49	60.73	7.84	62.05	46.85	42.38	3.09	47.25	38.68
T_2	10.84	55.78	7.47	61.42	46.63	42.42	2.85	45.74	37.79
T_3	9.66	63.54	7.10	72.18	58.70	42.14	3.24	48.24	47.44
T_4	9.46	59.66	6.74	72.36	38.45	42.05	2.52	39.47	54.56
T_5	9.15	67.66	6.41	74.79	60.86	33.66	3.87	32.41	57.92
T_6	9.94	65.85	6.50	73.75	59.86	33.18	3.55	33.48	55.72
T_7	10.46	59.81	7.31	62.42	57.96	42.42	3.18	47.59	40.58
T_8	10.50	58.54	7.11	61.45	56.70	42.43	2.56	47.91	37.92
T_9	10.69	47.60	7.94	51.97	35.84	51.95	2.95	50.17	33.68
T_{10}	10.46	45.24	7.98	51.73	34.57	52.37	2.07	51.23	32.02
T_{11}	12.65	35.85	9.32	42.19	32.51	62.08	1.94	53.21	24.45
SEd	0.245	1.025	1.002	0.985	1.211	0.986	0.125	1.024	1.861
CD (P=0.05)	0.547	2.096	2.145	1.240	2.456	2.054	0.258	2.541	3.021

T_1: Benzyladenine Purine, 100 Ppm; T_2: Benzyladenine Purine, 200 Ppm; T_3: Kinetin, 100 Ppm; T_4: Kinetin, 200 Ppm; T_5: Boric Acid, 2%; T_6: Boric Acid, 4%; T_7: Salicyclic Acid, 25 Ppm; T_8: Salicyclic Acid, 50 Ppm; T_9: Sodium Benzoate, 25 Ppm; T_{10}: Sodium benzoate, 50 Ppm; T_{11}: Control

CONCLUSION

The study investigated the efficacy of various post-harvest chemical treatments on jasmine flower buds, focusing on physiological parameters such as physiological loss in weight (PLW), moisture content, total phenol content, freshness index (FI), color retention index (CRI), flower opening index, fragrance index, browning index (BI), and shelf life. The results revealed that treating the flower buds with boric acid at a concentration of 2% significantly minimized physiological loss in weight, moisture content, and total phenol content compared to the control group. Additionally, the boric acid-treated buds exhibited superior freshness, color retention, fragrance, and lower browning index, resulting in an extended shelf life of 57.92 hours, in contrast to the control group's shelf life of 24.45 hours. These findings suggest that boric acid treatment at 2% concentration effectively mitigates senescence processes, preserves moisture content, reduces phenol accumulation, maintains freshness, color, fragrance, and delays browning, thereby enhancing the overall quality and extending the shelf life of jasmine flower buds. This study provides valuable insights for the floral industry, offering a promising method for post-harvest preservation and ensuring the prolonged marketability of jasmine flowers without compromising their aesthetic and olfactory attributes. Further research could delve into the mechanistic aspects of boric acid's action and its application in other floral varieties for enhanced post-harvest management.

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