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EFFECT OF POSTHARVEST TREATMENTS ON SHELF LIFE AND QUALITY OF JAMUN (*SYZYGIUM CUMINI* L. SKEELS) FRUITS

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ABSTRACT

A lab experiment was carried out to study effect of postharvest treatments on shelf life and quality of jamun (*Syzygium cumini* (L.) Skeels) fruits during 2024-25 at Dr. YSRHU- College of Horticulture, Venkatramannagudem. The study included 7 treatments each replicated thrice in completely randomized design. The treatments included control (Tap water), salicyclic acid (1mM and 1.5Mm), chitosan (1% and1.5%) and thyme oil (250ppm and 500pm). The primary objective was to evaluate how dipping jamun fruits in different chemical solutions influenced their physicochemical characteristics, sensory attributes, and storage longevity under refrigerated conditions (7 ± 1°C). The results revealed that chitosan at 1.5% (T_5) proved the most effective, recording the lowest decay incidence (28%) and minimal physiological weight loss (8.12%) on the 12th day after storage (DAS), while also extending the shelf life to 14.66 days. Treatment with chitosan at 1.5% also ensured a consistent increase in TSS (11.89 °Brix), better retention of titratable acidity (0.43%), and a favorable TSS:acid ratio (27.65). Moreover, it maintained higher levels of total sugars (8.99%), reducing sugars (6.69%), and non-reducing sugars (2.30%). In addition, it preserved the maximum ascorbic acid content (18.73 mg/100 g), retained higher anthocyanin concentration (121.29 mg/100 g), and sustained strong antioxidant activity (50.10% DPPH inhibition) at 12th DAS and also showed with maximum organoleptic scores.

***Key words*:** Jamun, shef life, decay, postharvest treatments, storage.

Introduction

Jamun [*Syzygium cumini* (L.) Skeels], commonly known as black plum, Indian blackberry, Java plum, Jambolan, or Duhat, is an indigenous fruit of the Indian subcontinent, belongs to *Myrtaceae* family. Globally, its production is estimated at approximately 13.5 million tonnes, with India contributing 15.4% of this output (Sankar *et al*., 2024). Within India, Maharashtra stands as the leading producer. In Indian culture, jamun holds significant religious importance often called the “Fruit of the Gods” in Hindu traditions. (Suma, 2020). Jamun is a tall evergreen tree with smooth white branch tips and reddish juvenile shoots, reaching 8-30 meters in height. It is commonly planted as an avenue tree or windbreak. The leaves are opposite, glossy, leathery and range from 6 to 12 cm in length with a sharp tip. The fruit itself is small, oblong and transitions from green to deep purple upon ripening. Its flesh is pink to white, juicy and mildly astringent, with seeds that vary in color from white to pink. The fruit is harvested during the May to July monsoon window, lasting roughly 30-40 days (Koley *et al*., 2011), and does not ripen further after picking.

Table 1: Effect of postharvest treatments on shelf life and decay of jamun fruits during storage period.

Treatments	Shelf life (Days)	Decay (%)			
		6 DAS	9 DAS	12 DAS	15 DAS
T_1- Control (Tap water)	9.33	12.00(20.25)**	44.00(41.50)**	64.00(53.10)**	*
T_2-Salicyclic acid @ 1mM	12.66	8.00(16.42)**	28.10(31.93)**	44.12(41.53)**	64.00
T_3- Salicyclic acid @ 1.5mM	14.33	4.00(11.53)**	15.00(22.77)**	32.11(34.43)**	56.33
T_4- Chitosan @1%	13.66	0.00(0.00)**	20.11(26.55)**	36.00(36.85)**	58.13
T_5- Chitosan @1.5%	14.66	0.00(0.00)**	12.00(20.26)**	28.00(31.93)**	52.00
T_6- Thyme oil @250ppm	12.33	8.00(16.42)**	32.00(34.43)**	44.00(41.53)**	76.00
T_7- Thyme oil @500ppm	11.00	12.00(20.25)**	36.00(36.85)**	52.00(46.12)**	*
SEm(±)	0.37	0.10	0.07	0.12	
CD at 1%	1.59	0.33	0.22	0.48	

DAS- Days after storage; *Indicates termination of storage; **Indicates figures in parenthesis indicate angular transformed values

Jamun is celebrated for its sweet, tart and sour taste with an astringent aftertone. Rich in vitamin C, fiber and antioxidants, it aids in blood purification, anemia management and metabolic health. Jamun boasts a wide range of bioactive compounds such as polyphenols, flavonoids, anthocyanins, glycosides, saponins and alkaloids (Rajkumar *et al.*, 2021). Jamun is a rich reservoir of essential nutrients and bioactive phytochemicals, including vitamins (ascorbic acid, retinol, niacin), minerals (calcium, iron, magnesium, phosphorus, potassium, sodium), sugars, amino acid. Fruit contain jamboline, a glycoside with antidiabetic characteristics that obstructs the transformation of starch into sugar (Ratsimamanga *et al*., 1973). Another compound, jambosine, contributes to jamun has antioxidant, anti-inflammatory,anti-microbial properties (Vaishnavi *et al*., 2024).

Material and Methods

The experiment was conducted at Fruit Science laboratory, Dr. YSRHU - College of Horticulture, Venkataramannagudem during 2024-25. The experimental design was Completely Randomized Design consists with 7 treatments and replicated thrice. The postharvest treatments involved dipping the fruits for five minutes into solutions of salicylic acid (1 mM and 1.5 mM), chitosan (1% and 1.5%), and thyme oil (250 ppm and 500 ppm). Control fruits received no treatment. After treatment, fruits were dried for 20 mins and all fruits were stored under refrigerator condition, and multiple observations were recorded systematically on days 3, 6, 9, and 12 during storage.

Preparation of post-harvest solutions

Preparation of different concentrations of Salicylic acid solution

The powdered form of salicylic acid does not dissolve in water, so it was first dissolved in a 0.1N NaOH solution (Kaviani *et al*., 2012). The solution was prepared as per the requirement and the fruits were treated. For the preparation of a 1 mM salicylic acid solution, 138.12 mg of salicylic acid was dissolved in 1 liter of 0.1N sodium hydroxide (NaOH). Similarly, to prepare a 1.5 mM salicylic acid solution, 207.18 mg of salicylic acid was dissolved in 1 liter of 0.1N NaOH. The prepared solutions were then used for fruit treatments.

Preparation of different concentrations of Chitosan solution

Chitosan solutions [1% and 1.5%(w/v)] were prepared by dissolving 10g and 15g of chitosan in 1000ml of distilled water containing 0.5 mL (v/v) of glacial acetic acid as a solvent. The solution was heated and agitated constantly for 1 hour and 0.5ml of Tween-20 was added as an emulsifier. The solution was adjusted to 5.6 with 1N NaOH (Ali *et al*., 2011).

Preparation of different concentrations of Thyme oil solution

Thyme oil solutions of two concentrations, 250 ppm and 500 ppm, were prepared by dissolving 0.25 ml and 0.50 ml of thyme oil, respectively, in 0.5 ml of Tween 20, which acted as an emulsifier to aid in oil dispersion. These mixtures were then diluted with 1000 ml of distilled water. To ensure proper incorporation of the thyme oil into the Tween 20 solution, the mixture was agitated on a magnetic stirrer for 30 minutes (Nabifarkhani *et al*., 2015)

Physical parameters

Shelf life (days)

The shelf life of fruits was determined by recording the number of days the fruits remained in good condition during storage. When the decay of fruits exceeded 50 per cent, it was considered the end of shelf life and expressed in days.

Decay Incidence (%)

The number of decayed fruits were counted at three days intervals from the total number of fruits and was calculated as a percentage, using the equation:

Table 2: Effect of postharvest treatments on physiological loss in weight of jamun fruits during storage period.

Treatments	Physiological loss in weight (%)			
	3 DAS	6 DAS	9 DAS	12 DAS
T_1- Control (Tap water)	6.62(2.76)**	8.62(3.10)**	11.86(3.58)**	*
T_2- Salicyclic acid @ 1mM	4.82(2.41)**	6.36(2.71)**	8.82(3.13)**	11.31(3.50)
T_3- Salicyclic acid @ 1.5mM	4.20(2.35)**	5.12(2.64)**	7.31(3.07)**	8.92(3.41)
T_4- Chitosan @1%	4.56(2.28)**	5.98(2.47)**	8.46(2.88)**	10.63(3.14)
T_5- Chitosan @1.5%	3.73(2.17)**	4.82(2.41)**	6.78(2.78)**	8.12(3.02)
T_6- Thyme oil @250ppm	5.00(2.44)**	6.90(2.82)**	9.10(3.17)**	11.62(3.55)
T_7- Thyme oil @500ppm	5.51(2.55)**	7.23(2.86)**	9.67(3.26)**	*
SEm(±)	0.11	0.13	0.16	
CD at 1%	0.46	0.57	0.68	

DAS- Days after storage; *Indicates termination of storage; **Indicates figures in parenthesis indicate angular transformed values

$$DI\% = \frac{\text{Number of decayed fruits}}{\text{Total number of fruits}} \times 100$$

Physiological loss in weight (PLW) (%)

Physiological loss in weight was determined by recording the initial weight of fruits on the day of initiating the experiment and subsequently at three-day intervals. Average of 25 fruits are taken for calculations of PLW. The loss of weight was calculated and expressed as a percentage.

$$PLW\% = \frac{\text{Initial weight - Final weight after storage}}{\text{Initial weight}} \times 100$$

Biochemical parameters

Total soluble solids (°Brix)

The total soluble solids were determined by using an ERMA hand refractometer and expressed as °Brix (Ranganna, 1986).

Titrable acidity (%)

For red pulp, titrable acidity was determined by following the procedure described by Ranganna, 1986 method. Five grams of pulp was crushed, homogenized and made up to 300 ml, and then filtered from it.10 ml of filtrate was taken into a 250 ml conical flask and a few drops of phenolphthalein indicator were added to 5 mL of clear extract and titrated against 0.1 N NaOH until it reached a light pink colour. The coloured solution was titrated by diluting a 5 mL sample with a large volume of distilled water (300ml). The color becomes so pale that indicator colour changes during titration can easily be observed.

$$\text{Titrable acidity \%} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times 0.0064}{\text{Volume of aliquot taken}} \times 100$$

Total antioxidant activity (% DPPH activity)

The percentage of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of the samples was determined by a method described by Eghdami and Sadeghi (2010). A sample of 0.1 ml of methanol (control) was mixed with 3.9 ml of a 25 mg/L methanolic solution of DPPH (2, 2-diphenyl-1-picrylhydrazyl) and methanol was used as a blank. The mixture was vortexed thoroughly for 1 minute and at 37°C temperature for 30 minutes in darkness and then the spectrophotometer absorbance was read against a blank at 517 nm.

$$\text{DPPH inhibition activity (\%)} = \frac{A_{517\,nm} \text{ of control} - A_{517\,nm} \text{ of sample}}{A_{517\,nm} \text{ of control}} \times 100$$

Results and Discussion

The data presented in Tables 1, 2, 3, 4, and 5 and results revealed that the shelf life, decay incidence, physiological loss in weight, TSS, titrable acidity and total antioxidant of jamun were significantly influenced by different concenrations of treatments.

Shelf life (days)

Among the postharvest treatments tested, the maximum shelf life of 14.66 days was observed in fruits treated with chitosan @ 1.5% (T5) followed by salicylic acid @ 1.5 mM (T3) which maintained a shelf life of 14.66 and 14.33 days, respectively. The minimum shelf life was recorded in control (9.33 days), followed by fruits

Table 3: Effect of postharvest treatments on total soluble solids (TSS) of jamun fruits during storage period.

Treatments	Total soluble solids (°Brix)			
	3 DAS	6 DAS	9 DAS	12 DAS
T_1- Control (Tap water)	12.75	13.11	10.86	*
T_2-Salicyclic acid @ 1mM	12.55	12.72	12.91	11.49
T_3- Salicyclic acid @ 1.5mM	12.17	12.49	12.62	11.76
T_4- Chitosan @1%	12.38	12.62	12.78	11.61
T_5- Chitosan @1.5%	12.07	12.36	12.57	11.89
T_6- Thyme oil @250ppm	12.68	12.87	13.12	11.40
T_7- Thyme oil @500ppm	12.70	12.93	12.12	*
SEm(±)	0.02	0.006	0.008	
CD at 1%	0.11	0.024	0.033	

DAS- Days after storage; *Indicates termination of storage

Table 4: Effect of postharvest treatments on titrable acidity (TA) of jamun fruits during storage period.

Treatments	Titrable acidity (%)			
	3 DAS	6 DAS	9 DAS	12 DAS
T_1- Control (Tap water)	0.52(1.23)**	0.46(1.20)**	0.38(1.17)**	*
T_2- Salicyclic acid @ 1mM	0.55(1.24)**	0.48(1.21)**	0.45(1.20)**	0.37(1.17)
T_3- Salicyclic acid @ 1.5mM	0.57(1.25)**	0.52(1.23)**	0.49(1.22)**	0.4(1.18)
T_4- Chitosan @1%	0.55(1.24)**	0.50(1.22)**	0.46(1.20)**	0.39(1.17)
T_5- Chitosan @1.5%	0.58(1.25)**	0.54(1.24)**	0.51(1.22)**	0.43(1.19)
T_6- Thyme oil @250ppm	0.53(1.23)**	0.57(1.25)**	0.42(1.19)**	0.35(1.16)
T_7- Thyme oil @500ppm	0.53(1.23)**	0.46(1.20)**	0.40(1.18)**	*
SEm (±)	0.015	0.01	0.01	
CD at 1%	NS	0.06	0.06	
DAS- Days after storage; *Indicates termination of storage; **Indicates figures in parenthesis indicate angular transformed values				

treated with thyme oil @ 500 ppm (11.66 days). Chitosan @ 1.5% was found to be effective in enhancing the shelf life of the fruit. It could be due to low decay incidence (28%), high antioxidant activity (50.10%) at 12th DAS which extended the shelf life by 5.33 days as compared to control fruits. Chitosan forms a semipermeable film on the fruit surface that creates a modified atmosphere around the fruit, providing physical barrier supports its role in increasing the fruit shelf-life. (Xing *et al*., 2016) The results were in concord with the results of Chien *et al*., (2007) in citrus fruits (Murcot tangor).

Decay Incidence (%)

During storage, the highest decay incidence was observed in fruits treated with tap water (T1), reaching 12% and 44%, on the 6th and 9th respectively, followed by fruits treated with thyme oil at 500 ppm (T7) showed comparatively lower decay (12%, 36%, and 52%) on 6th, 9th and 12th DAS, while the lowest incidences were recorded in fruits treated with chitosan at 1.5% (T5), with 12% on the 9th day and 28% on the 12th day. No decay was observed in fruits treated with chitosan (1% and 1.5%) on the 6th day. Application of chitosan creates a thin coating on the fruit surface, which functions as a protective barrier by limiting gas exchange, reducing water loss, minimizing shrivelling, and thereby slowing down physiological deterioration. The present results were in conformity with the findings of Saurabh *et al.*, (2019) in jamun.

Physiological loss in weight (%)

Fruits treated with tap water (T1) consistently showed the highest weight loss values (6.62%, 8.62% and 11.86% on 3rd, 6th and 9th DAS, respectively). Conversely, fruits treated with 1.5% chitosan (T3) exhibited the least physiological weight loss, recording values of 3.73%, 4.82%, 6.78% and 8.12% on the 3rd, 6th, 9th and 12th days of storage, respectively. This was followed by fruits treated with 1.5 mM salicylic acid, which showed weight loss values of 4.20%, 5.12%, 7.31% and 8.92% at the corresponding intervals. Chitosan coating which works by forming micropores that moderate gas exchange while preventing rapid water molecule loss from the fruit surface and restricting water vapour transmission while allowing controlled respiration. This mechanism significantly reduces the primary cause of physiological weight loss. (Bal, 2018). The results were in the line with the findings of Hesami *et al*., (2021) in ber.

Total soluble solids (TSS) (ºBrix)

A gradual increase and then decreased in TSS was observed during the storage period. The initial TSS of

Table 5: Effect of postharvest treatments on Total antioxidants of jamun fruits during storage period.

Treatments	Total antioxidants (% DPPH Inhibition)			
	3 DAS	6 DAS	9 DAS	12 DAS
T_1- Control (Tap water)	60.70(51.16)**	50.10(45.00)**	40.60(39.50)**	*
T_2-Salicyclic acid @ 1mM	64.00(53.13)**	58.80(50.00)**	51.20(45.60)**	43.60(41.46)
T_3- Salicyclic acid @ 1.5mM	74.70(59.80)**	63.70(52.90)**	54.50(47.56)**	47.20(43.53)
T_4- Chitosan @1%	72.00(58.00)**	56.20(48.50)**	50.20(45.00)**	41.50(40.20)
T_5- Chitosan @1.5%	77.20(61.40)**	68.90(56.10)**	59.30(50.34)**	50.10(45.20)
T_6- Thyme oil @250ppm	62.96(52.43)**	54.60(47.60)**	47.50(43.50)**	40.20(39.40)
T_7- Thyme oil @500ppm	61.74(51.72)**	53.32(46.81)**	42.30(40.00)**	*
SEm (±)	0.18	0.10	0.19	
CD at 1%	0.78	0.43	0.67	
DAS- Days after storage; *Indicates termination of storage; **Indicates figures in parenthesis indicate angular transformed values				

jamun fruits was recorded as 11.32 °Brix on the 0th day. During storage, TSS levels increased, with the 3rd to 6th day showing the highest values in control fruits (tap water: T1, from 12.75 to 13.11 °Brix), while the lowest values were observed in chitosan @ 1.5% (T5: 12.07 to 12.36 °Brix). A gradual decline was noted thereafter in control (T1) showed the lowest TSS (10.86 °Brix) on 9th day. By the 12th and 15th days, TSS decreased in all treatments, but fruits coated with chitosan @ 1.5% (T5) retained the highest values (12.57 and 11.89 °Brix, respectively), while control fruits consistently recorded the lowest TSS. This initial increase may be attributed to the concentration of soluble solids resulting from the conversion of organic acids into sugars during metabolic processes. Chitosan modifies the internal atmosphere created by the chitosan coating, characterized by reduced O, and elevated CO, levels, which slows down sugar utilization, delays the degradation of carbohydrates and other soluble solids, thereby maintaining TSS levels for a longer period during storage. These findings were consistent with the reports of Upadhyaya and Dixit (1996) in aonla.

Titrable acidity (%)

The results indicated significant differences in titrable acidity among the treatments across all storage intervals, except on 3rd day, where no significant variation was observed. Overall, titrable acidity decreased progressively during the storage period. The initial titrable acidity of the fruits was 0.61%. Among the treatments, fruits treated with tap water (T1) exhibited the lowest titrable acidity, recording values of 0.46%, and 0.38% on the 6th and 9th DAS, respectively. In contrast, the highest titrable acidity was observed in fruits under chitosan @ 1.5% treatment with values of 0.54%, 0.51%, and 0.43% on 6th, 9th, and 12th DAS, respectively. A similar decreasing trend in titrable acidity during storage was reported by Shafiee *et al.*, (2010) in strawberries. Islam *et al.*, (2013) observed that chitosan coatings help to delay the decline in titrable acidity by reducing the metabolic breakdown of acids that typically occurs during ripening and storage, thereby preserving fruit acidity and extending shelf life during storage.

Total antioxidants (% DPPH inhibition)

Throughout the storage period, a consistent decline trend was recorded in the antioxidant content of the fruits. Post-harvest dipping treatments had a significant effect on the total antioxidant content of the fruits.

At the beginning of storage (0th day), the DPPH inhibition was 87.6%. By the 3rd day, the highest antioxidant level (77.20%) was recorded in fruits treated with chitosan at 1.5% (T5), followed by salicylic acid at 1.5 mM (T3), which maintained 74.70%. In contrast, the lowest antioxidant content (60.7%) was observed in fruits treated with tap water (T1). A similar trend was observed on subsequent days of storage (6th, 9th, and 12th DAS), with chitosan at 1.5% (T5) consistently showed the highest retention.

Lowest % DPPH inhibition activity at the end of the storage period, likely due to the degradation and oxidation of phenolic compounds, ascorbic acid, and anthocyanins. Chitosan coatings supports antioxidant enzyme activity, such as catalase, peroxidase, and those involved in the ascorbate-glutathione cycle. This enhanced enzymatic activity helps neutralize reactive oxygen species (ROS) and reduces membrane degradation in the stored fruits (Wang *et al.*, 2024). Similar results were reported by Badawy and Rabea (2009) in tomato.

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